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Current News
PHILADELPHIA

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Supplement - April, 1917

"The Power Company and the Distribution of Electrical Energy"

By

WILLIAM C. L. EGLIN

PHILADELPHIA - ELECTRIC - CO. - SECTION
NATIONAL - ELECTRIC - LIGHT - ASSOCIATION

PHILADELPHIA·ELECTRIC·CO·SECTION

"FIFTH OLDEST IN THE N. E. L. A."

OF THE

NATIONAL · ELECTRIC · LIGHT · ASSOCIATION

Organized, March 15th, 1909

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W. E. LONG . . . . . Vice-Chairman
W. J. LOCHART . . . . . Secretary
FRED RUSSELL . . . . . Asst. Secretary
H. R. KERN . . . . . Treasurer

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THOMAS SPROULE 1911-12
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JOS. B. SEAMAN 1913-14
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H. P. LIVERSIDGE 1915-16

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NATIONAL · ELECTRIC · LIGHT · ASSOCIATION

29 WEST 39TH STREET, NEW YORK, N. Y.
H. A. WAGNER, BALTIMORE, MD., PRESIDENT
T. COMMERFORD MARTIN, SECRETARY

ESTABLISHED: FEB. 25, 1885 - - - MEMBERSHIP: OVER 15,000
GEOGRAPHIC SECTIONS: 11, (INCLUDES CANADIAN ELECTRICAL ASSOCIATION)
COMPANY SECTIONS: 64

Date Due

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THE United States had not entered the Great War at the time the contents of this *Supplement* was prepared.

However, in the light of the President's Proclamation appearing in the press on April 16th, 1917, the work of the American Power Companies takes on the significance of national service.

Recognized as an important part of what the President has termed "a great national, a great international *Service Army*" because of their close and necessary relationship to the industrial forces of the country, the Power Companies today stand ready to perform whatever may be required of them in the service of the Nation.

It is because of *this*, that service in the Power Companies takes on the significance of *national service.*

President, The Philadelphia Electric Co.
Past-President,
The National Electric Light Association

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SECTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION

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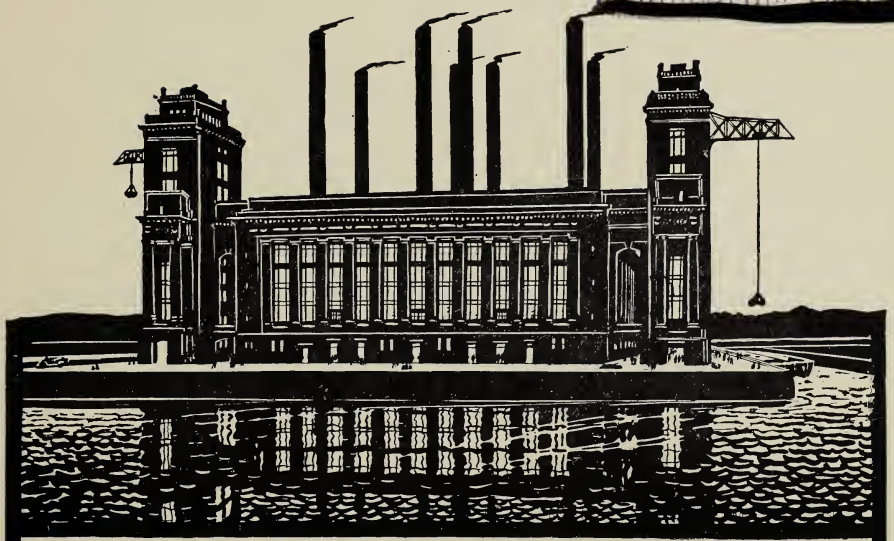


"THE POWER COMPANY AND THE DISTRIBUTION OF ELECTRICAL ENERGY"

By WILLIAM C. L. EGLIN
2d VICE-PRESIDENT AND CHIEF ENGINEER
THE PHILADELPHIA ELECTRIC COMPANY
PAST-PRESIDENT
THE NATIONAL ELECTRIC LIGHT ASS'N

DEDICATED TO THE AMERICAN TECHNICAL UNDERGRADUATE

PHILADELPHIA

PENNSYLVANIA

FOUNDED 1683 BY WILLIAM PENN
BIRTHPLACE OF AMERICAN LIBERTY: JULY 4, 1776

"The World's Greatest Workshop and · The · City · of · Homes"

THIRD LARGEST CITY IN THE UNITED STATES
ELEVENTH LARGEST CITY IN THE WORLD
POPULATION: 1,750,000 (1917)
AREA: 129½ SQUARE MILES

Output of Philadelphia's Factories, $1,000,000,000 (for Year 1916); Number of Manufacturing Establishments, 8,400 (Census 1914); Employees: Male 197,500, Female 88,400 (Census 1914); Total Yearly Payroll of Philadelphia's Manufactories, $185,500,000; Number of Homes, 373,000; Home Ownership, 150,000; Parks and Squares, 86; Acreage, 6,400; Recreation Centers, 33; Schools, 217; Average Attendance, 193,000 (December, 1916); Miles of Streets, 1,700; Street Railway Trackage, 625 miles

o o o

The · PHILADELPHIA · ELECTRIC COMPANY · SYSTEM

STATISTICS AS OF JANUARY 1st, 1917

Number of Generating Stations, 4; Capacity, 200,000 Kilowatts	
Number of Sub-Stations (Distribution)	30
Number of Customers	95,000
Kilowatt-Hours Generated (Year 1916)	445,000,000

621.311
Eg5p

CURRENT NEWS
PHILA. ELEC. CO. SECTION N·E·L·A
"A N.E.L.A. BOOSTER"

EDITOR FOR THIS ISSUE
R. PHILIP HART, 2ND
ENGINEERING DEPARTMENT

Vol. XIII APRIL, 1917, SUPPLEMENT No. 9

FOREWORD

THE purpose of the following pages is to point out the opportunities for university-trained men *in the Power Companies*—the sense of that which now is written having been presented in talks to students at Yale and Princeton Universities.

The prerogative that I assume in presenting at greater length what I feel to be very real opportunities, may be likened to the rural Congressman's "leave to print", and is with the hope that it may be of some help to the undergraduate who is at the cross-roads in his choice of a life-work.

The work of preparing this in printed form has been carried on by Mr. Charles Penrose and Mr. R. Philip Hart, 2nd, who have gathered the statistics and have prepared the supplement in its present form, and to whom my thanks are extended.

April, 1917.

Wm B Eglin

603923

THE POWER COMPANY AND THE DISTRIBUTION OF ELECTRICAL ENERGY

:: By WM. C. L. EGLIN ::

A PAPER PRESENTED BEFORE PRINCETON UNIVERSITY, ON FEB. 28, 1917

INTRODUCTION

IN addressing you Princetonians tonight, I have divided the subject of "The Power Company and the Distribution of Electrical Energy" into six divisions. While I shall touch upon hydro-electric developments, my remarks so far as plant property is concerned are more applicable to the larger metropolitan systems of Eastern U. S. A.

The divisions which I have made are these:

FIRST:
The Electrical Industry as shown by *national statistics,* and the standing of the Power Company in the United States today.

SECOND:
The Power Company's Growth (historically) and the reasons therefor.

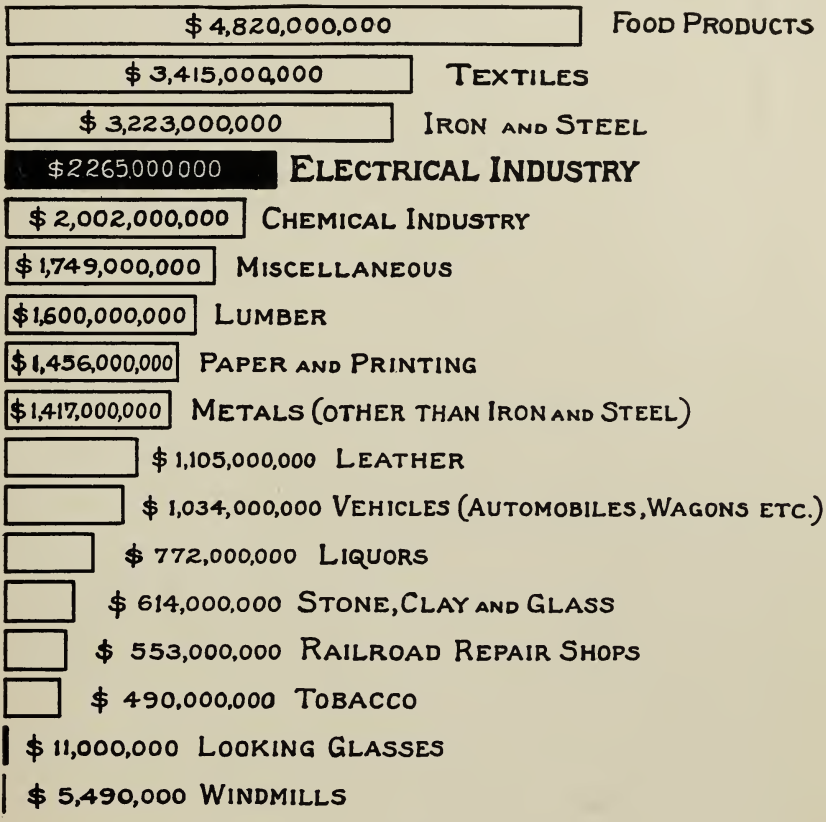
THIRD:
The Field occupied by the Power Company today.

FOURTH:
How the Power Company Distributes Electrical Energy. (An Outline of Plant Property and Apparatus.)

FIFTH:
The Power Company's Problems and Future, and the *Opportunity for Technically-trained Men in the Industry.*

SIXTH:
The Human Side of the Power Company's Organization.

With this brief introduction, let us turn our attention at once to the first of the above divisions, namely, the Electrical Industry and the standing of the Power Companies.



THE ELECTRICAL INDUSTRY IN U. S. A.

STANDING IN 1914

RANKED ACCORDING TO VALUE OF PRODUCTS
(U. S. CENSUS 1914, BEING LATEST OBTAINABLE DATA)

THE "POWER COMPANY" INDUSTRY

NATIONAL STATISTICS

SECTION 1:

IT seems logical in any discussion that the most comprehensive statistical figures should be given first, and, therefore, I am going to call your attention at the outset to the following rather startling figures for the whole Electrical Industry in the United States, based on the most recent statistics of the Bureau of the Census.

In 1914, the *two billion two hundred and sixty-five million dollar* gross income of the whole electrical industry ranked *fourth* among the fourteen leading industries of this country.

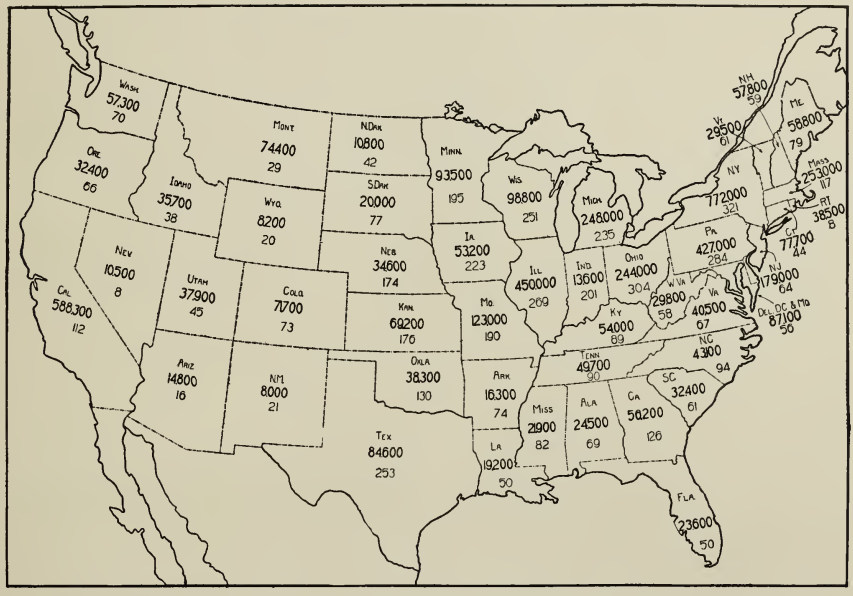
The rank of "fourth" may convey little to some of us, but when we consider that the tabulation of figures on the Electrical Industry by the Census authorities dates back only to the year 1902, when the gross income was shown as $718,000,000, and that the present standing as given above is surpassed by only three other industries, namely, Food Products, Textiles and Iron and Steel, in the order named, then we arrive at a very definite concept of the position to which the Electrical Industry as a whole has attained.

Another way of looking at the relative importance of these figures, and to use what is now a time-honored criterion, is that this gross income for the whole electrical industry for the year 1914 represents six times the total cost of the Panama Canal (given as $375,000,000).

It is an interesting coincidence, that the gross income for 1914 for the Power Company Industry happens to be exactly equal to the cost of the canal.

Rather than go further into a mass of statistics, which at best are only comparative, I have had prepared a number of diagrams intended to show graphically some of the characteristics of the Industry. They include not only the standing, growth and development of this Industry, financially and technically, but show also the growth and development of some of the related interests; for example, that of the steam boiler and prime mover. This development, although in a different field of engineering, was inspired and fostered by the electric generator. Certain interesting economic comparisons are shown, which, upon analysis, you will find include the *factors* that have benefited alike the Power Company and its customers, bringing about the present-day standing of the Industry.

The appended *charts* are self-explanatory.



LARGE FIGURES DENOTE K W. CAPACITY — SMALL FIGURES DENOTE NO. OF COMPANIES

GEOGRAPHICAL DISTRIBUTION OF THE POWER COMPANY INDUSTRY IN THE UNITED STATES, 1912

NATIONAL STATISTICS FOR 1912

FROM LATEST U. S. CENSUS STATISTICS

COMPANIES:
Total Number 5,221

GENERATORS:
Total Capacity, 5,135,000 k.w.

PRIME MOVERS:
Total Capacity, 7,529,000 h. p.

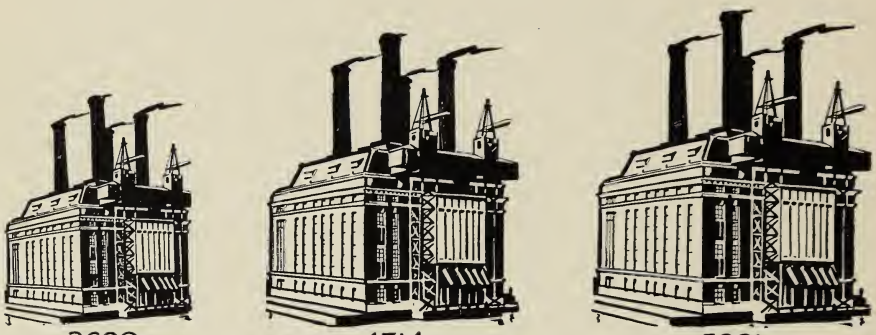
WHICH ARE DRIVEN, AS FOLLOWS:
By Steam Engines and Turbines . . . 4,947,000 h. p.
By Water Wheels and Turbines . . . 2,471,000 h. p.
By Gas Engines, 111,000 h. p.

PERSONS EMPLOYED:
Total Number 79,335

INCOME (for Year 1912):
Total $302,000,000

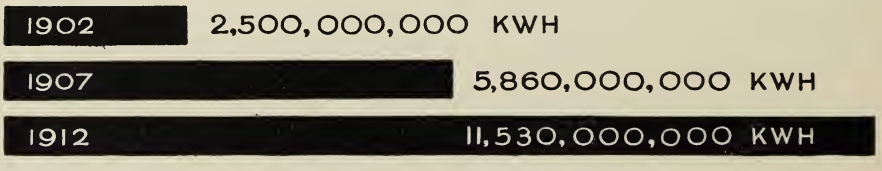
OUTPUT (for Year 1912):
Total Kilowatt Hours, 11,500,000,000

LOAD SERVED:
Lamps:
Total Number . 77,000,000
Motors:
Total Number . . 435,000
Total Cap'y, 4,131,000 h. p.



NUMBER OF COMPANIES

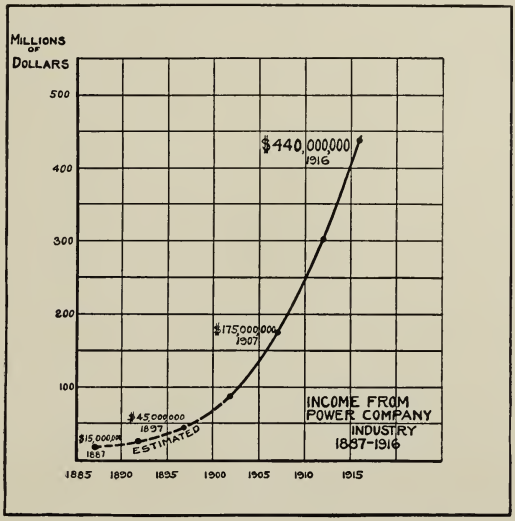
KILOWATT CAPACITY OF GENERATORS



OUTPUT OF ALL STATIONS

THE GROWTH OF THE POWER COMPANY INDUSTRY 1902-1912

U. S. Census Report



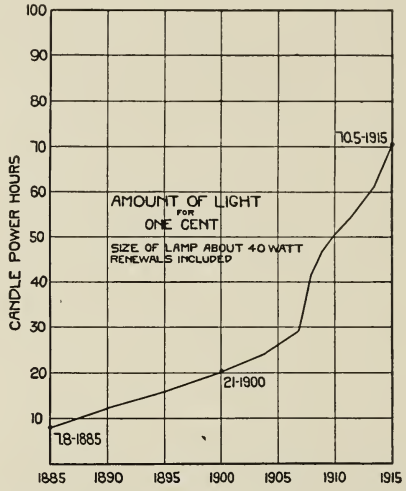
NUMBER OF PERSONS EMPLOYED IN THE POWER COMPANY INDUSTRY IN U.S.A.

1902
30,300

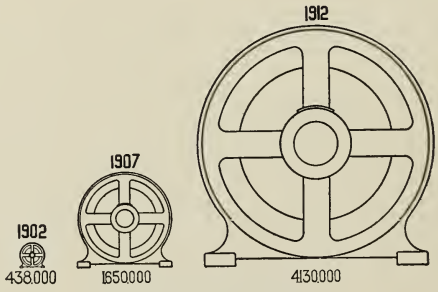
1907
47,600

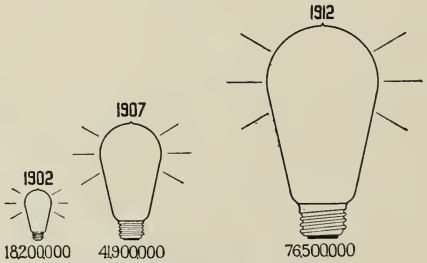
1912
79,300

—From *U. S. Census Report, 1912*

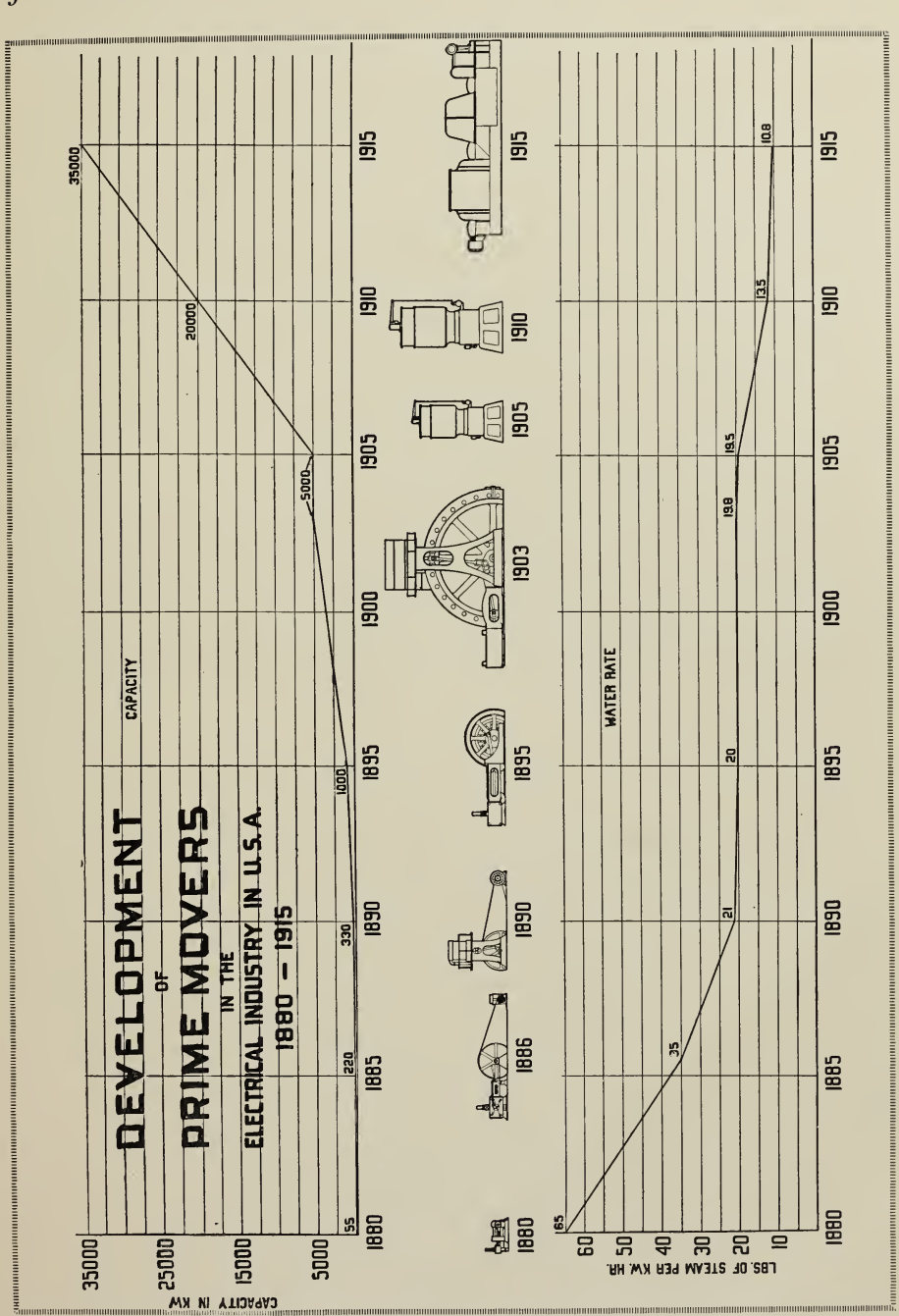


ECONOMIC DEVELOPMENT OF ELECTRIC LIGHTING—1885-1915

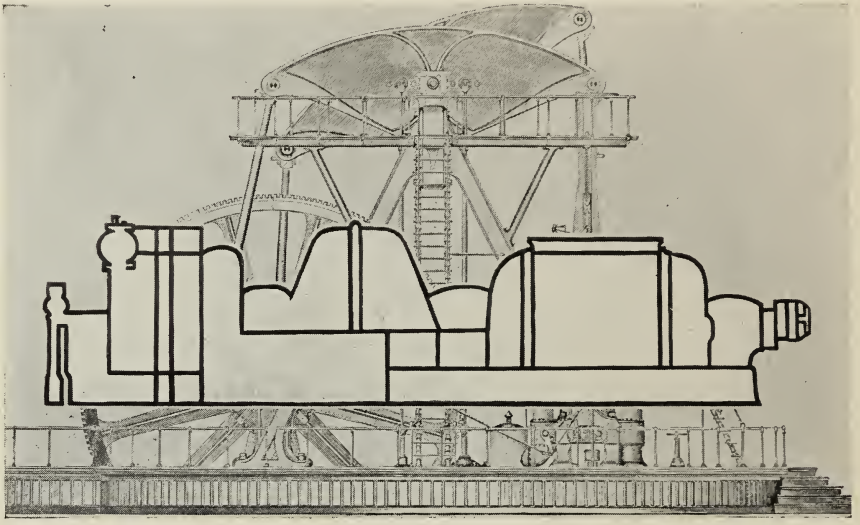




GROWTH OF LOAD, POWER COMPANY INDUSTRY: 1902-1912—U. S. CENSUS REPORT


DEVELOPMENT
OF
PRIME MOVERS
IN THE
ELECTRICAL INDUSTRY IN U.S.A.
1880 – 1915
CAPACITY
CAPACITY IN KW
35000
25000
15000
5000
55
220
330
1000
5000
20000
35000
1880
1885
1890
1895
1900
1905
1910
1915
1880
1886
1890
1895
1903
1905
1910
1915
WATER RATE
LBS. OF STEAM PER KW. HR.
60
50
40
30
20
10
65
35
21
20
19.8
19.5
13.5
10.8

CORLISS (1876) VERSUS CURTIS (1915)



The Corliss Engine: Side Elevation.

CORLISS · 1876

INSTALLED AT CENTENNIAL EXHIBITION · PHILADELPHIA

1400 Horse-Power

Cylinders: Diameter, 40 inch Stroke, 10 feet

Diameter of Platform, 55 feet

Height, 39 feet

Total Weight, 680 tons

Speed, 36 R.P.M.

Steam Pressure, 25 to 80 pounds per square inch

Steam Consumption, 25 lb. per H. P. Hour (approximate)

CURTIS · 1915

INSTALLED AT STATION A-2 PHILADELPHIA ELECTRIC CO.

47,000 Horse-Power (35,000 Kilowatts)

Length, 63 feet, 2½ inches

Width, 21 feet, 7½ inches

Height, 15 feet, 10½ inches

Total Weight, 415 tons

Speed, 1200 R. P. M.

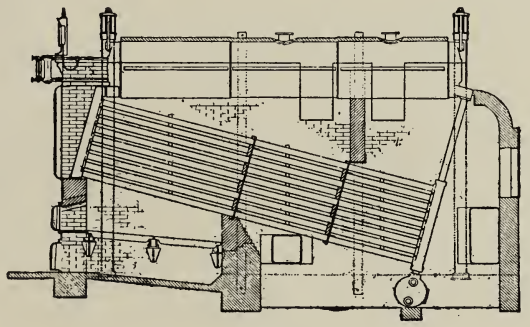
Steam Pressure, 215 pounds per square inch

Steam Consumption, 7.2 lb. per H. P. Hour

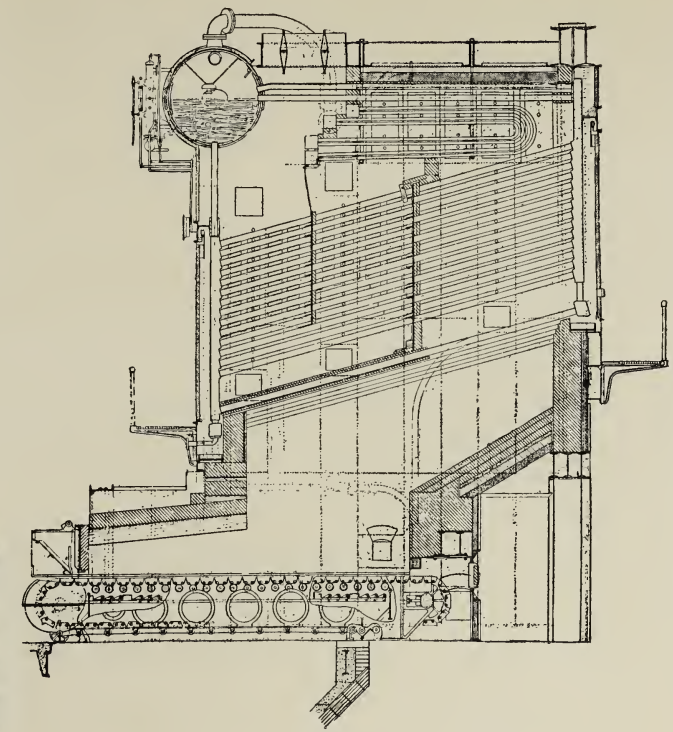
STEAM BOILER DEVELOPMENT
1884-1917

COMPARISON OF OLD AND MODERN
BABCOCK AND WILCOX BOILERS
BEST POWER COMPANY PRACTICE

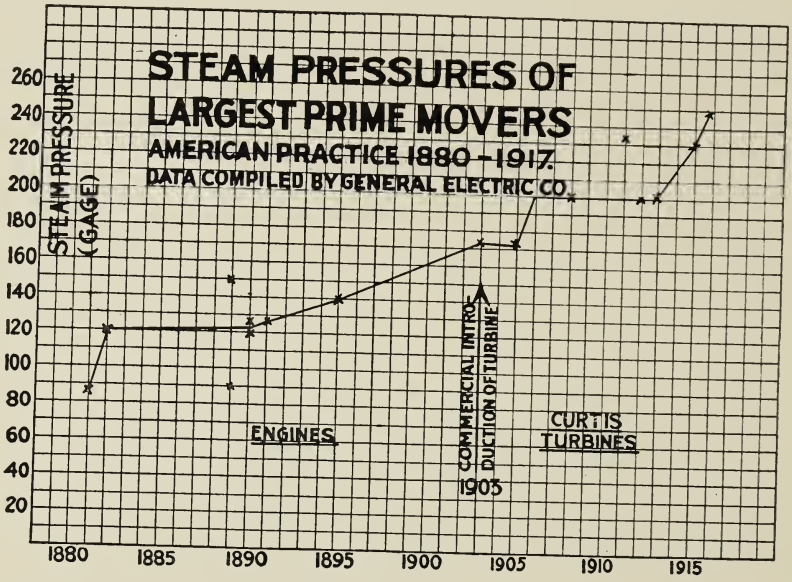
	1884	1917
Date of Installation	1884	1917
Rated Horse Power (10 sq. ft. per H. P.)	266	1440
Maximum Load: Per Cent. of Rating	100%	225%
Pressure: lb. per sq. in.	90	300
Quality of Steam	99% Dry	250° F. Superheat
Method of Firing	Hand	Chain Grate Stokers

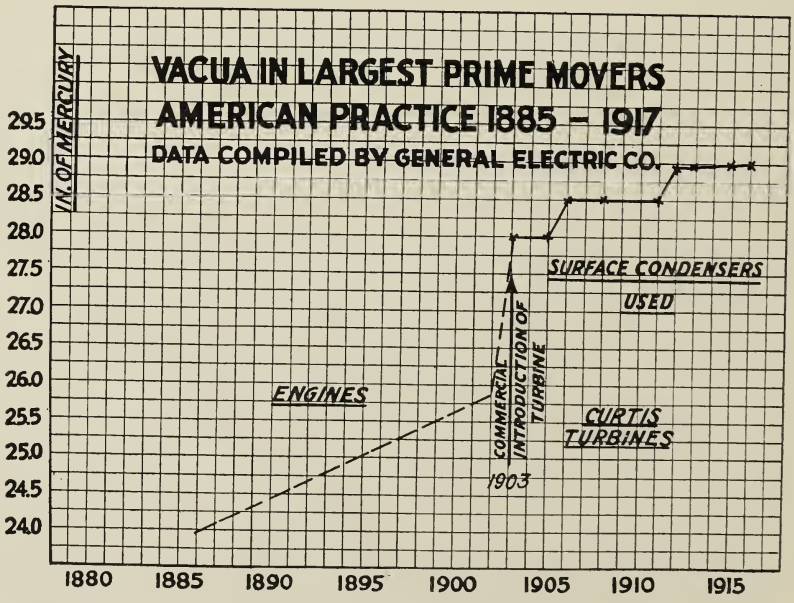


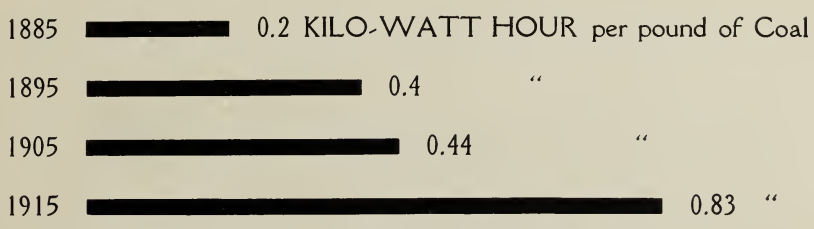
1884



1917


STEAM PRESSURES OF
LARGEST PRIME MOVERS
AMERICAN PRACTICE 1880 – 1917.
DATA COMPILED BY GENERAL ELECTRIC CO.
STEAM PRESSURE (GAGE)
260
240
220
200
180
160
140
120
100
80
60
40
20
ENGINES
COMMERCIAL INTRODUCTION OF TURBINE
1903
CURTIS TURBINES
1880
1885
1890
1895
1900
1905
1910
1915


VACUA IN LARGEST PRIME MOVERS
AMERICAN PRACTICE 1885 – 1917
DATA COMPILED BY GENERAL ELECTRIC CO.
IN. OF MERCURY
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
25.0
24.5
24.0
SURFACE CONDENSERS USED
ENGINES
COMMERCIAL INTRODUCTION OF TURBINE
1903
CURTIS TURBINES
1880
1885
1890
1895
1900
1905
1910
1915

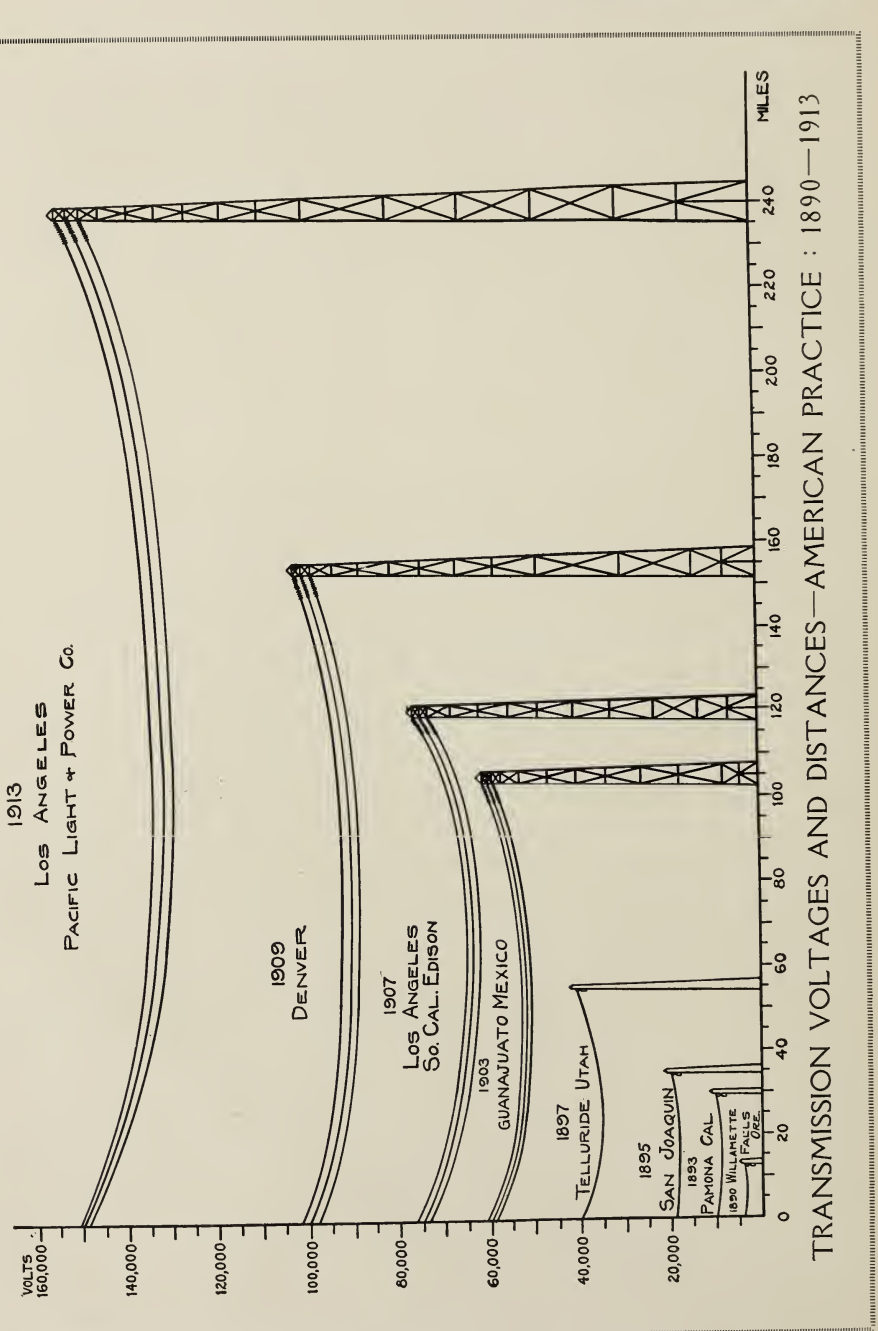


"THE UTILITY VALUE OF A POUND OF COAL"

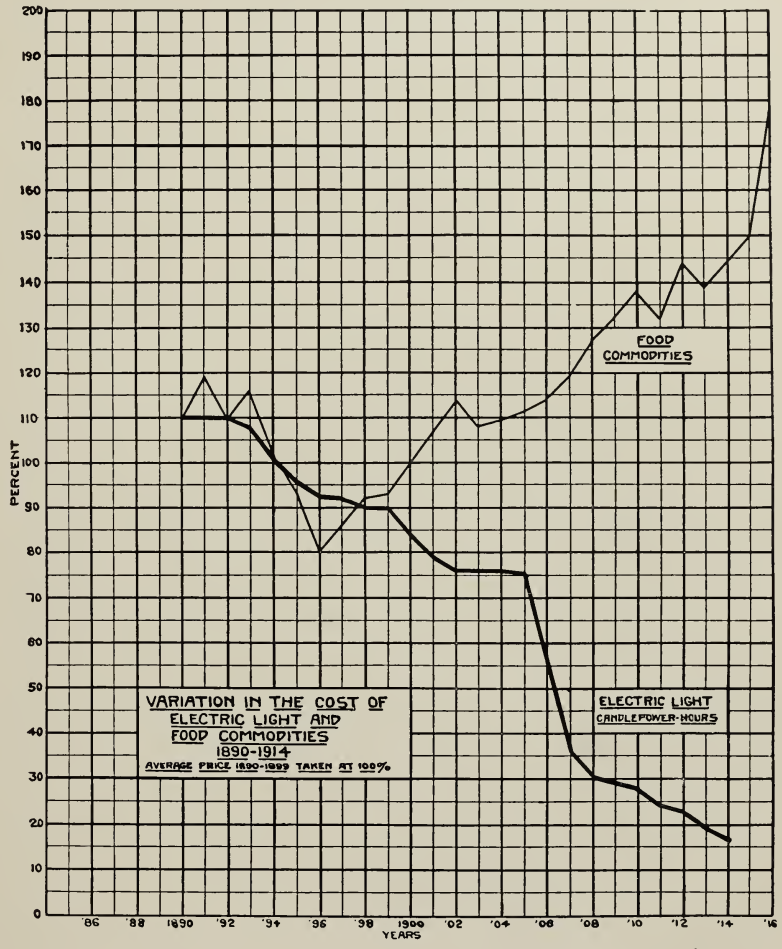
The above chart shows graphically what enormous progress has been made in obtaining the energy of coal through the medium of *Steam Prime-Movers* and *Electric Generators.* The following tabular comparison (upon which the above is based, and which assumes coal having a uniform calorific value) shows that, while considerable progress has been made in burning coal, i. e., the evaporation, the really *Great Progress* has been made in the development of the *Steam Prime-Mover:*

YEAR	EVAPORATION WATER PER LB. COAL	WATER-RATE STEAM PER K.W.H.	"UTILITY VALUE" K.W.H. PER LB. COAL
1885	7 lb.	35 lb.	0.2 k.w.h.
1895	8 "	20 "	0.4 "
1905	8.5 "	19.5 "	0.44 "
1915	9 "	10.8 "	0.83 "

The above represents best practice of the *American Power Companies,* at the date noted



TRANSMISSION VOLTAGES AND DISTANCES—AMERICAN PRACTICE : 1890—1913



From Compilation by General Electric Co.

"An interesting ECONOMIC COMPARISON is found in the variation in the cost of electric light and food commodities, during the years 1890 to 1916."

THE POWER COMPANY'S GROWTH (HISTORICALLY) AND THE REASONS THEREFOR

SECTION II:

THE history is an intensely interesting one, of what popularly we may term "the distribution of *power,*" but by which we mean in a strictly technical sense "the distribution of *energy*"—a physical distinction which you will readily recognize.

The history of the Power Company may be carried back to almost the beginning of industrial activities.

You may recall, and there are still in existence in certain parts of the country, Power Company canals, through which *water* was fed to factories and utilized by means of water wheels or turbines.

These water-power companies were limited by natural conditions, *i. e.,* to localities where water for this purpose was readily available.

With the invention of the *steam* engine by Watt in 1769, the field for the generation and transmission of energy was very much enlarged.

Watt's steam engine, whose first use you remember was in pumping out water from the coal mines in Wales, was slowly evolved, as time progressed, into the type of prime mover available at the birth of the Electrical Power Company Industry—no longer ago than the early eighties of the last century.

But in the interim, between the time of Watt and the practical introduction of electricity, there is a long period—one also of gradual development.

Briefly, to run over this period:

As the steam engine and steam boiler were progressively developed and larger sizes were perfected, mechanical energy was transmitted within a community by means of line shafting, belts and cable.

At one time the direct distribution of high-pressure steam by pipes laid in the street, was tried; probably the most notable example of this being in New York City, where the steam was generated at a central point and piped to the customers' premises, to operate steam engines which they installed and maintained.

Compressed air, also, has been used as the means of transferring energy from the Power Company to its customers. This offered some advantages; for example, in mines, by assisting in the ventilation of the mine.

The *territorial area* which could be served by any of these methods was comparatively small. This was because of limitations due to losses in

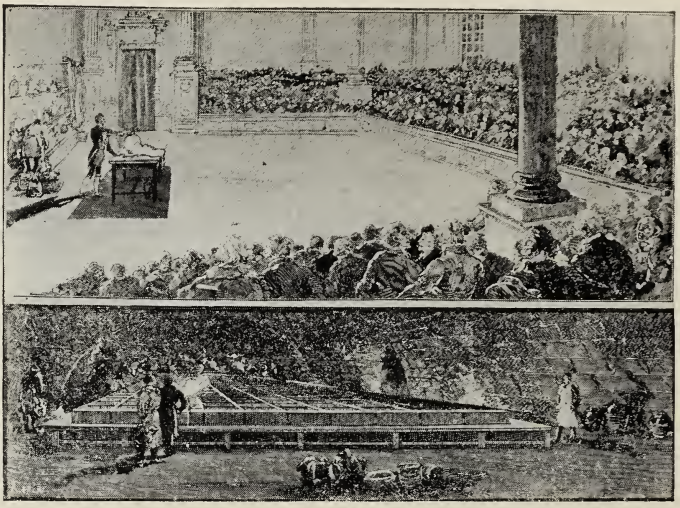
transmission, the high cost of construction and poor overall efficiency. So that we may say that it was not until the development of dynamo-electric machinery, which enabled a reasonably large area to be served from a single power house, that any marked advance was made in the transmission of energy. One reason lay in the fact that for the first time large loads could be carried by conductors or mains of reasonable size, with relatively small losses in transmission, and with good and constantly improving overall efficiencies.

I was particularly interested to see in your museum, here, today, some of the experimental apparatus of Professor Henry, whose discoveries in 1838 in the field of electro-magnetic induction had such bearing in making possible the whole modern system of transmission and distribution of electrical energy. These discoveries, which I am told were made by him within the walls of your classical Nassau Hall, I feel should be perpetuated, and I would like to suggest that the engineering students of Princeton might well erect a suitable memorial to keep this brilliant work before the electrical engineering profession of the country, and to serve as a reminder to every visitor to your university. In this connection I will include here an abstract from the "Proceedings" of the American Philosophical Society, Vol. 1, p. 14, May 4, 1838, in which I find the following: "Dr. Patterson read a letter from Professor Henry, of Princeton, dated May 4, 1838, announcing that in recent experiments he had produced directly from ordinary electricity, currents by induction analogous to those obtained from galvanism, and that he had ascertained that these currents possess some peculiar properties; and that they may be increased in intensity to an indefinite degree, so that if a discharge from a Leyden jar be sent through a good conductor a shock may be obtained from a contiguous but perfectly insulated conductor more intense than one directly from the jar. Professor Henry remarks that he has also found that all conducting substances screen the inductive action, and that he has succeeded in referring this screening process to currents induced for a moment in the interposed body."

The chronology of the important steps in the development of electrical apparatus which led up to and made possible modern electrical engineering and the modern Power Company is given as follows:

Probably the earliest electrical discovery or invention which is related to the Power Company industry, was that of the arc lamp in 1810, by Sir Humphry Davy. The batteries which Davy used were Voltaic piles, whose inception dates to 1799 *(circa),* when they were discovered by the Italian physician, Volta. Previous to Davy's experiments a good deal of work had been done in electrostatics and magnetism, which, of course, bore its fruits later on, but which can hardly be said to be related, except remotely, to the Power Company industry.

Continued on page 23



"THE FIRST EXHIBITION OF THE ELECTRIC LIGHT—1810"

"We give an illustration of no small historic interest. It represents the first exhibition of the electric light by Sir Humphry Davy, at the Royal Institution in London, in 1810, and we reproduce it from 'La Lumiere Electrique.' The date is so recent as to belong to our own times. The story of the display may be briefly told. As our readers know, Volta announced in 1800 the invention and construction of his pile, the first source of dynamic electricity. A year later, Davy, only twenty-one or twenty-two years of age was appointed assistant lecturer at the Royal Institution, and, entering upon his duties with zeal and ardor, he was not slow to avail himself of the means for investigation and experiment placed at his disposal there in the Voltaic pile. He made good use of the earlier batteries provided, but in 1808 found himself in possession of a battery of Brobdingnagian proportions, purchased by the subscriptions of a few generous patrons of science. It consisted of 2,000 cells, arranged in 200 porcelain troughs in a vault, after the manner indicated in the lower portion of our illustration.

"Davy had discovered and shown the carbon light on a very small scale in 1802, having learned how to obtain an 'arc' by holding together two pieces of charcoal that were connected to the opposite poles of a battery and then drawing them apart; and he could now repeat his experiment on a grand scale and with startling brilliancy before the members of the Institution. It is well to give his own description of the display: 'When pieces of charcoal about an inch long and one-sixth of an inch in diameter were brought near each other (within the thirtieth or fortieth part of an inch) a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness; and, by withdrawing the points from each other a constant discharge took place through the heated air in a space equal to at least four inches, producing a most brilliant ascending arc of light, broad and conical in form in the middle.' The length of this arc was increased in vacuo to seven inches. The delight and surprise of the spectators was evidently very great."

—*Electrical World*, April 12, 1884.

The earliest discoveries leading to the development of dynamo-electric machinery were those of Faraday, who, in 1821, discovered electro-magnetic rotation. Barlow, in 1823, made a simple electric motor, consisting of a copper disk, whose edge dipped into a bath of mercury. It was not until 1831 that Faraday discovered that he, using a disk much like Barlow's (see page 24) could produce electric currents. This was really the FIRST ELECTRIC GENERATOR, the direct ancestor of all our modern turbo-alternators and all present-day dynamo-electric machines. Faraday's wonderful work did not stop there; in the same year he discovered the "magneto-electric induction of currents," which is the underlying principle of the modern transformer. About this same time, as I have already pointed out, Henry, in the United States, was making very important discoveries in electro-magnetic induction; you are, of course, familiar with the fact that the unit of electro-magnetic induction bears his name. Henry also built an electric motor which worked on the principle of electro magnets attracting oscillating plungers.

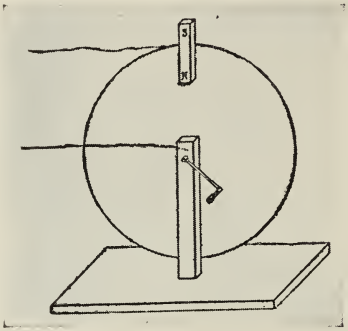
The next development came from Pixii, a Frenchman, who, at the suggestion of his friend, Ampère, brought out a dynamo (page 24). In this crude machine a marked advance was made over Faraday's disk machine by the substitution of a wound electro-magnet with many turns of wire for use as an armature, in place of Faraday's copper disk which had but one path for current. Pixii also used a crude two-part commutator—THE EARLIEST COMMUTATOR KNOWN.

The years 1833-38 saw several attempts made in the construction of motors, among which were those of Jacobi and Davenport (see page 24). These motors, like several others of this period, really worked, and *probably would have been developed much faster had it not been for the prohibitive expense of electrical energy,* all of which had, at that time, to be obtained from batteries. It is interesting to note what the inventors of motors accomplished who were well backed financially: Jacobi, for example, ran a boat on the Neva (see page 24), while Page, at a later date, made an electro-magnetic motor with plungers, developing ten horse-power. Several attempts were made to drive printing presses electrically, while others tried to make electric locomotives practical, with varying success.

Up to 1845, several men had built crude generators, all of them employing permanent magnets for their fields, but in this year Wheatstone and Cooke took out patents for the use of ELECTRO-MAGNETS FOR FIELDS. This suggestion, although a most important one in the light of later developments, does not appear to have met with any marked success on its inception, and it was not until 1863 *(circa)* that we hear of a machine being built which made use of their scheme. Another important suggestion was that of self-excitation, made by Jacob Brett in 1848; this also was destined to lie unused until several years later.

Continued on page 26

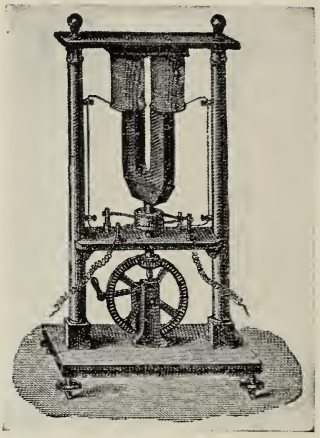
HISTORICAL ELECTRICAL APPARATUS



1831

FARADAY'S DISK DYNAMO

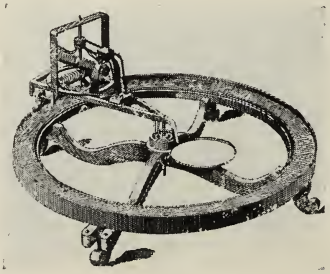
"Faraday, in 1831, showed that by rotating a copper disk mechanically between the poles of a magnet, continuous currents were obtained."



1832

PIXII'S "ALTERNATE CURRENT" MACHINE

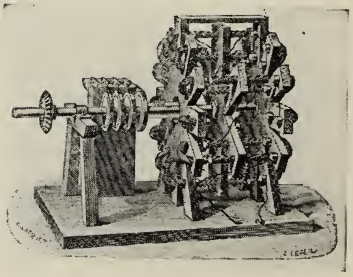
"So far as known, the first machine to generate the so-called 'alternate' currents."



1837

DAVENPORT'S ELECTRIC RAILWAY MOTOR—*A Model*

"The motor exhibited is one of a considerable number made by Davenport, of Brandon, Vermont, U. S. A. in 1837."

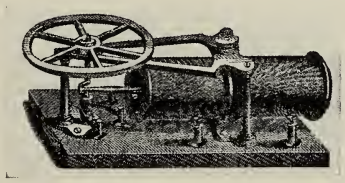


1838

JACOBI'S ELECTRIC MOTOR

"This motor, installed in a boat at the command of Czar Nicholas, propelled the boat at less than 3 miles per hour. The fumes from its supply batteries had to be carried off through a smokestack."

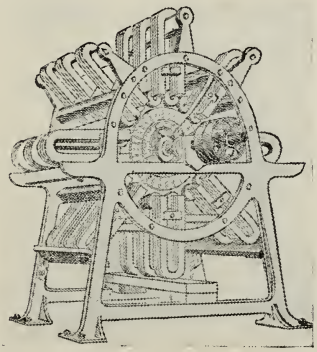
HISTORICAL ELECTRICAL APPARATUS



1851

DU MONCEL'S ELECTRIC MOTOR

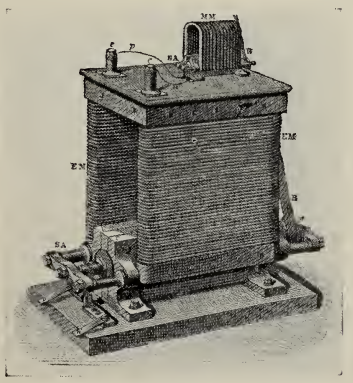
"One of several futile attempts to use the solenoid in electric motors. A larger motor of similar description was constructed by Prof. Page of the Smithsonian Institute in 1850, which developed 10 horse power."



1863

ALLIANCE MACHINE FOR "ALTERNATE CURRENTS"

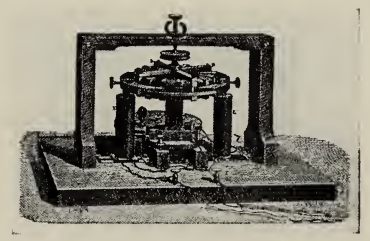
"Built by Messrs. Holmes, du Moncel and Masson, and for many years used in Lighthouses in Great Britain and France."



1863

WILDE'S MACHINE

"Wilde, of Manchester, England, devised a machine which was 'excited' by a small permanent magnet dynamo, mounted on its summit."



1864

PACINOTTI'S DYNAMO

"Probably the earliest multi-segment commutator machine, and the first machine which would run either as generator or motor."

The year 1856 saw the birth of Werner Siemens' "SHUTTLE-WOUND" ARMATURE. This important step in advance was one of the many made by Dr. Siemens. About the same time important progress was being made in the construction of dynamo-electric machines by Holmes, an Englishman. In 1857, he exhibited a machine which received the highest praise from Faraday; he followed this in 1862 by an extraordinary machine for direct current. Some idea of its general characteristics may be gained from the fact that it had 160 bobbins arranged on wheels nine feet in diameter; these bobbins swept past powerful permanent magnets fixed fast to a frame. Records do not tell whether this remarkable machine was successful or whether it received Faraday's good wishes. However, it suffered some modification by Holmes himself working in connection with DuMoncel and Masson. This trio in 1863 brought out the "Alliance" machine (page 25), evidently retaining some of the features of Holmes' earlier machines. The "Alliance" has the distinction of being the FIRST MACHINE TO GENERATE CURRENT FOR AN ECONOMIC PURPOSE; these machines were used for years to light many important French and British lighthouses.

The few years following 1863 were particularly prolific in new types and important discoveries in generators. One of the most important was the building, by Pacinotti in 1864, of a machine (see page 25), having two important features, *viz.:* a SIXTEEN-PART COMMUTATOR and what amounted to A RING ARMATURE. The machine fell into temporary oblivion but was later recognized to be of great merit. During the same period, Wilde, of Manchester, England, carried on a remarkable series of experiments which produced a machine having electro-magnets for fields, excited by a small permanent-magnet machine. (See page 25.) This was probably the FIRST EXCITER ever used. Wilde, in 1873, made his machine self-exciting by using a commutator. This, however, was not the first self-excited generator, for the reason that in December, 1866, S. A. and C. Varley patented a machine which seems to have been the first to make use of "RESIDUAL" for starting. Their patent was followed closely by two other discoveries of the same thing, made independently. January 17, 1867, Dr. Werner Siemens described a self-excited machine to the Berlin Academy*, and on February 14th of the same year, Sir C. Wheatstone made an almost identical suggestion to the Royal Society. Later in 1867, a self-exciting generator was built by Ladd, whose machine had two armatures on the same shaft, one for supply and one for excitation. The suggestion to use self-excitation made in 1848 by Brett does not appear to have borne fruit until this year.

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*On this occasion, Dr. Siemens coined the name *"dynamo-electric machine,"* later abbreviated to the familiar *"dynamo."*

The year 1870 marked the introduction by Gramme of his famous RING ARMATURE. A little later, 1873, Hefner Alteneck took up the "shuttle" armature of Siemens and rewound it, spacing the several turns at equal angles around the circumference, and adding a multi-segment commutator, in order to produce a less fluctuating voltage. Dr. Henry Rowland, of this country, also worked out independently a "drum" wound armature which was used with great success.

Charles Francis Brush, an inventor of remarkable brilliancy, took up the problem of electric lighting in 1875, and in a few months had developed and perfected an arc light and dynamo which achieved marked success in 1876. Some of his early machines were used for many years, so far were they in advance of arc machines of that date.

In 1878, Pacinotti devised an armature which had its windings placed radially on a flat disk; this form of machine was later developed for use with arc lights, but became obsolete, never having been widely used. During this same year Edison attacked the problem of building generators. His first attempt was a machine having oscillating motion, evidently to get rid of the commutator and its attendant troubles. The oscillating idea was not a new one, having been tried previously by Dejardin, 1856; Siemens, 1859, and Wilde in 1861. Edison abandoned the oscillating motion in 1879, and produced what later was modified to be his familiar BIPOLAR "TYPE Z" MACHINE (page 33). In 1881, he attempted unsuccessfully to build a disk machine along the same lines as Pacinotti's of 1878.

It should be noted here that on October 21, 1879, Mr. Edison made his first successful incandescent lamp, the *first high resistance lamp* and the first to be used for parallel operation. The importance of this invention to the development of the industry can hardly be overestimated.

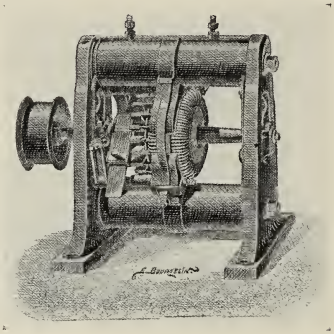
In 1880, the "open coil" machine was brought out by Elihu Thomson and Houston. This same machine was used to a large extent on arc light circuits. Later, the "open coil" idea was adopted by several other makers.

In 1881, Marcel Deprez came to the certain theoretical conclusions with regard to the excitation of field coils. These conclusions led him to devise the COMPOUND WINDING, which soon was adopted by many makers. Lord Elphinstone, Crompton and Hopkinson about this time drew attention to perfecting the magnetic circuit of generators to improve their regulation. This development led to the MULTI-POLAR MACHINE in several forms.

Just later than this Frank J. Sprague made the important discovery that motor speed with increasing load could be regulated in much the same way that generator voltage was with increasing current. This prominent American inventor also evolved the prototype of the modern *interpole*

Continued on page 30

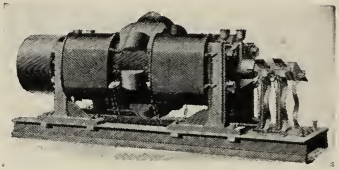
HISTORICAL ELECTRICAL APPARATUS



1870

GRAMME'S MACHINE

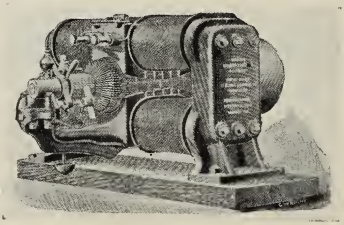
"Z. T. Gramme, the Frenchman, introduced the ring armature; the machine shown was the prototype of many machines using this construction."



1876

BRUSH ARC DYNAMO

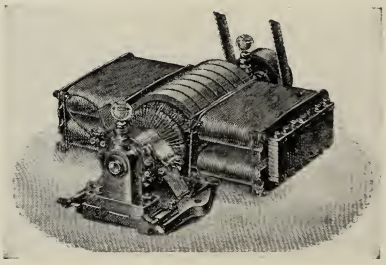
"This machine employed the Pacinotti ring armature and had the enormous e.m.f. of nearly 3000 volts. Was adapted to lighting 25 arc lamps in series."



1880

WESTON DYNAMO

"Weston, in particular, developed shunt-wound direct-current dynamos. Early type shown."

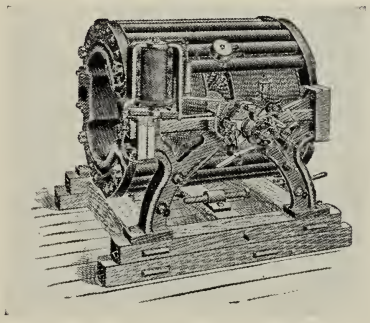


1885 (circa)

SIEMAN'S DYNAMO

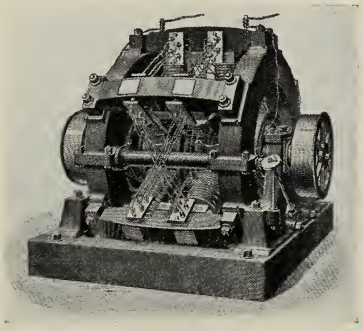
"This machine employed the shuttle-wound armature, which although invented in 1856 by Siemens, appears not to have been used until this later date."

HISTORICAL ELECTRICAL APPARATUS



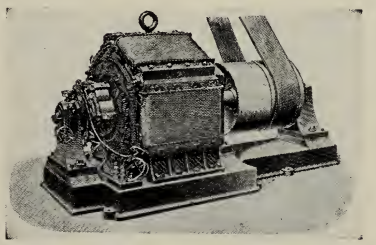
1880
THOMSON-HOUSTON
ARC DYNAMO

"One of the several types of Arc Dynamos in common use before the introduction of the constant current transformer."



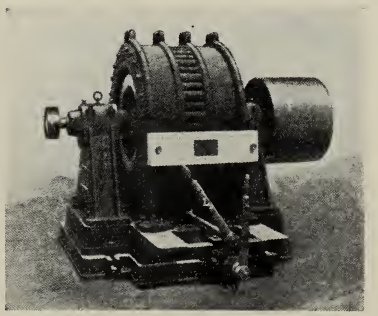
1885
DEPREZ GENERATOR

"M. Deprez used this generator in his epoch-making experiments on the transmission of power by electricity."



1885
THURY'S DYNAMO

"Thury's dynamo was one of the earliest multipolar machines."



1894
STANLEY INDUCTOR
ALTERNATOR

"Stanley's alternator which had no copper on the moving parts, was widely used for single and polyphase work."

motor. From that date on, the development of the direct-current motor and generator have kept very much abreast.

The considerable success of Edison's generator and the introduction of his lamp on a commercial basis brought the problem of distribution to the front with great emphasis.

This problem which Edison had to face was no small one, for up until the time of his generator the parallel system of distribution had never been used. His solution consisted in the "feeder and main" and the three-wire systems, whose importance to the industry can hardly be overestimated.

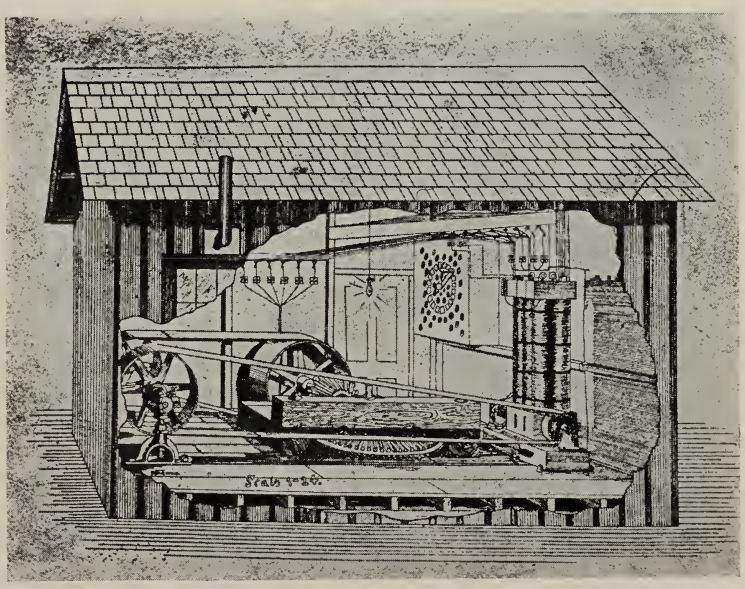
The Edison system of distribution, although it was the most advanced of the time and even stands today as the standard method for direct-current and secondary alternating-current distribution, has certain limitations. The most important of these is that the investment in copper mains for transmitting energy any considerable distance increases extremely rapidly with the distance. This limitation was at first overcome by building several power plants centrally located with respect to the communities which they were to serve. In the large cities such as New York, many independent power houses were built, each serving its own immediate territory, of which it usually occupied the load center. The objections to this method of electrical supply, in the light of our later experiences, were several. In the first place, the position of the plant was determined by one condition and one only, namely, the location of the load. All other economic conditions, such as railroad facilities, value of real estate, proper water supply had to go unconsidered in view of the one master determining condition, location of the load.

The greatly increased demand for electric service led inventors to cast about for a more satisfactory means of distribution. The first approach toward solution was started in 1884, when Mr. George Westinghouse, with his characteristic foresight, acquired the patent rights of the European inventors, Messrs. Gaulard and Gibbs, for the alternating-current system. Their system however was in crude form, consisting of several *"converters"* (since called "transformers") whose primaries were connected in series and whose secondaries supplied independent circuits. William Stanley, a resident of Great Barrington, Massachusetts, took up the system, and in 1885 made transformers which he connected in multiple. Later in that same year, he successfully lighted stores and residences at Great Barrington. This installation was the FIRST COMMERCIAL DISTRIBUTION SYSTEM USING ALTERNATING CURRENTS. The work of William Stanley was followed closely by the Westinghouse Company, who, in 1886, conducted the famous LAWRENCEVILLE TEST, at which time energy at 1,000 volts pressure was transmitted two miles, single phase. The "load" consisted of three hundred incandescent lamps which were lighted continuously during a period of about two weeks.

Continued on page 34

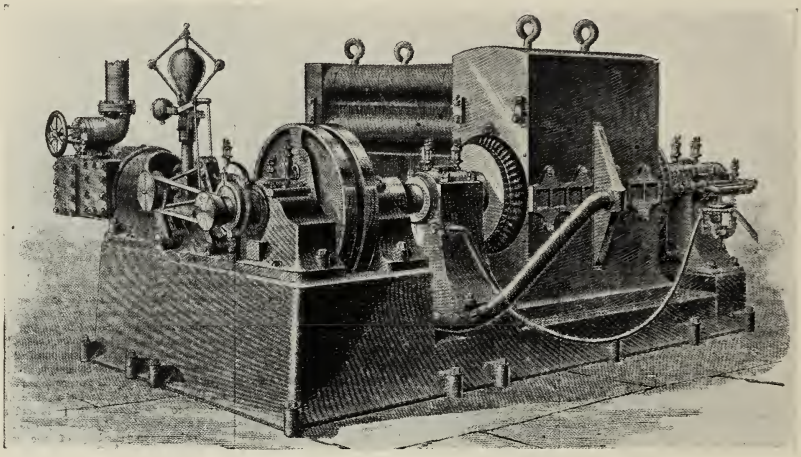
for **APRIL, 1917**

THE WORLD'S FIRST ELECTRICAL CENTRAL STATION
APPLETON, WISCONSIN—1882



PLANT CAPACITY 250-10 C. P. LAMPS—APPROX. 12½ K.W. THE EARLY EDISON DYNAMO WAS DRIVEN BY WATERPOWER. REGULATING APPARATUS IS SHOWN

HISTORICAL ELECTRICAL APPARATUS

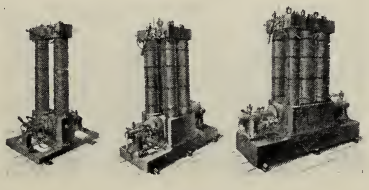


THE EDISON STEAM DYNAMO

"WHEN Mr. Edison attacked the problem of electric lighting, some five years ago, he both felt and expressed the conviction that its economic and practical solution was to be obtained more easily and more satisfactorily by aiming at installations on a large scale for supplying light to large districts. However, this proposition to generate in a central station the current necessary for a large number of lamps and to distribute this to the consumer just as gas and water are supplied, from a system of steam mains, was ridiculed by electricians as chimerical, and even speculators on such novel business shrugged their shoulders in doubt as if realizing the absurdity of the proposition. The plan of light-restricted areas and buildings separately by means of small, isolated plants seemed the most feasible. The most readily adaptable — in a word, the most practical, and was sanctioned by the great majority of electricians and engineers, while it received the immediate encouragement of capitalists. For a long time, it seemed that Mr. Edison had made a mistake and made rash promises. The experiments tending toward the realization of the project were numerous, protracted, and many of them unsuccessful. But finally, the difficulties were overcome and the long-predicted possibility was at last demonstrated.

It results from all this that the idea of generating electricity on a large scale has been growing into favor among the electrical engineers, and has now arrived at a point of being considered as the most practicable. The procedure adopted by the various subsidiary and local companies who undertake the lighting and illumination of cities and towns, is a direct

HISTORICAL ELECTRICAL APPARATUS



EARLY TYPES OF EDISON'S GENERATORS

proof of this. But the idea of a large installation entails other considerations, that of the size of the generators, it is necessary to determine whether it is more practical to use a large number of small dynamos or else fewer large ones in an installation of great capacity. The question is easily answered, for there are important reasons which argue in favor of large dynamos. Just as in producing steam power, a single large engine is preferable to a number of small ones, so in this case, the use of large dynamo-electric machines affords greater efficiency and convenience, while the complication and cost are materially reduced. A large dynamo may be belted or even coupled direct to the engine, thus obviating the necessity of countershafting and the multiplication of belting which are indispensible when small dynamos are used.

We present herewith an illustration of one of the six dynamos in use at the Pearl Street station.

The large Edison dynamos are intended to supply enough current for 24,000 lights of 8 candles or 12,000 of 16 candles.

The supply of current adapts itself to the use made of it by those supplied with the Edison light, the regulation being accomplished by a variation of the resistance introduced into the field-magnet circuit. The large dynamos are all connected in multiple circuit to the mains, and they are all kept at a uniform electro-motive force near the standard adopted (110 volts), regulation being effected simultaneously in all. It is the intention to keep part of the dynamos running, one or two being kept in readiness to serve as relays in case of accident to any of the others. At present, however, the demand on the system by consumers is so great that at dusk it is necessary to keep five dynamos in operation. It is estimated that at this time there are over 55,000 of the lights being used in the district. The present capacity of the station is, therefore, well taxed, and the Company is unable to satisfy the demands of new applicants for lights until the new dynamos have been put into operation, which will probably be within a couple of months."

—FROM *Electrical World*, NOVEMBER 3, 1883, PAGE 155, VOL. II

The epoch-making experiments of Stanley and the Lawrenceville test were followed shortly by the *commercial use of alternating current* on a large scale. Starting with a plant at Greensburg, Pa., then one at Buffalo, N. Y., the alternating-current system made such strides that *within two years* after the Great Barrington work, two hundred alternating-current plants were in operation!

It was in 1885 that the National Electric Light Association was founded, which institution has since grown to such large membership and usefulness. The association's name was not at that time a misnomer, for not until that same year had electrical energy been used for commercial power purposes. The introduction of the SPRAGUE MOTOR *(1884)* was the first step toward the now widespread use of electric power.

The year 1888 saw several important advances in the art. The invention by Shallenberger of a meter for measuring alternating-current energy was of great importance. During this same year, the problem of alternating-current motors was being attacked by Messrs. Nikola Tesla and Ferraris. The former achieved the greater success, his motor being very simple and practical.

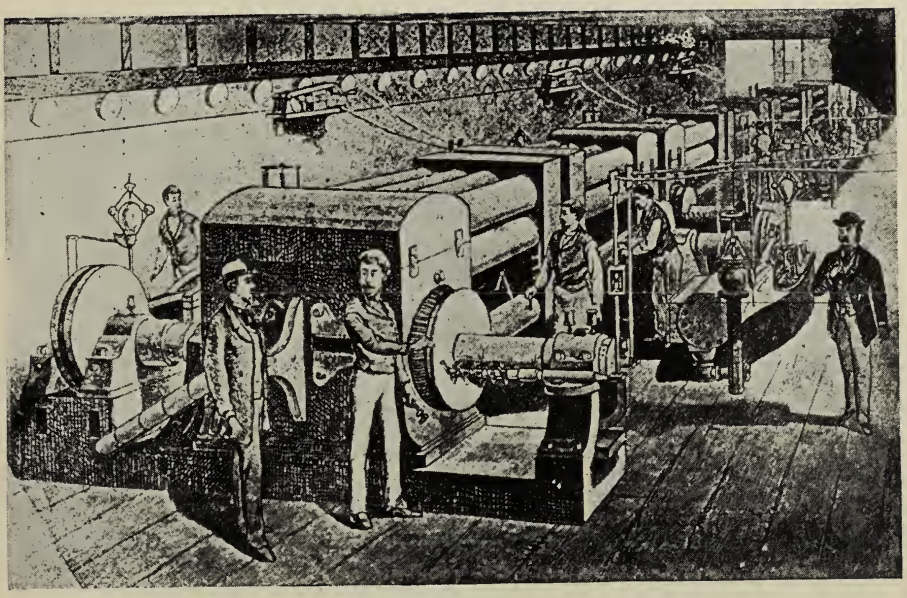
It must be noted here that, judged by modern usage, the frequencies of the early installations had all been extremely high, the usual values being 125 or 133 cycles per second. This high frequency made it possible to construct transformers cheaply and was satisfactory for lighting purposes. However, as it was found impossible to make an induction motor run on such frequencies, most of Tesla's experiments were carried on using special polyphase alternators of a much lower periodicity. About 1892, when the tremendous opportunity for the induction motor was seen, it became apparent that the high frequency single-phase system must be abandoned in favor of a lower frequency POLYPHASE SYSTEM. As it was Tesla's motor which necessitated this new system of polyphase circuits, his name was given to the system as well as to the motor. At this time, the Westinghouse Company adopted 60 cycles for lighting and 30 cycles for power purposes.

The year 1888 marked the introduction by Frank J. Sprague of his multiple control system for railway service. This system of control, which has since become of the most vital importance in coping with the problems of modern transportation, gave the transportation industry of that day an added impetus and greatly stimulated its growth.

It was about this time that Edward W. Weston was doing some of his most important work along the lines of developing electrical measuring instruments.

Although his early and very successful work was on the incandescent lamp, the arc lamp and the plating dynamo, the really signal service which he

Continued on page 41



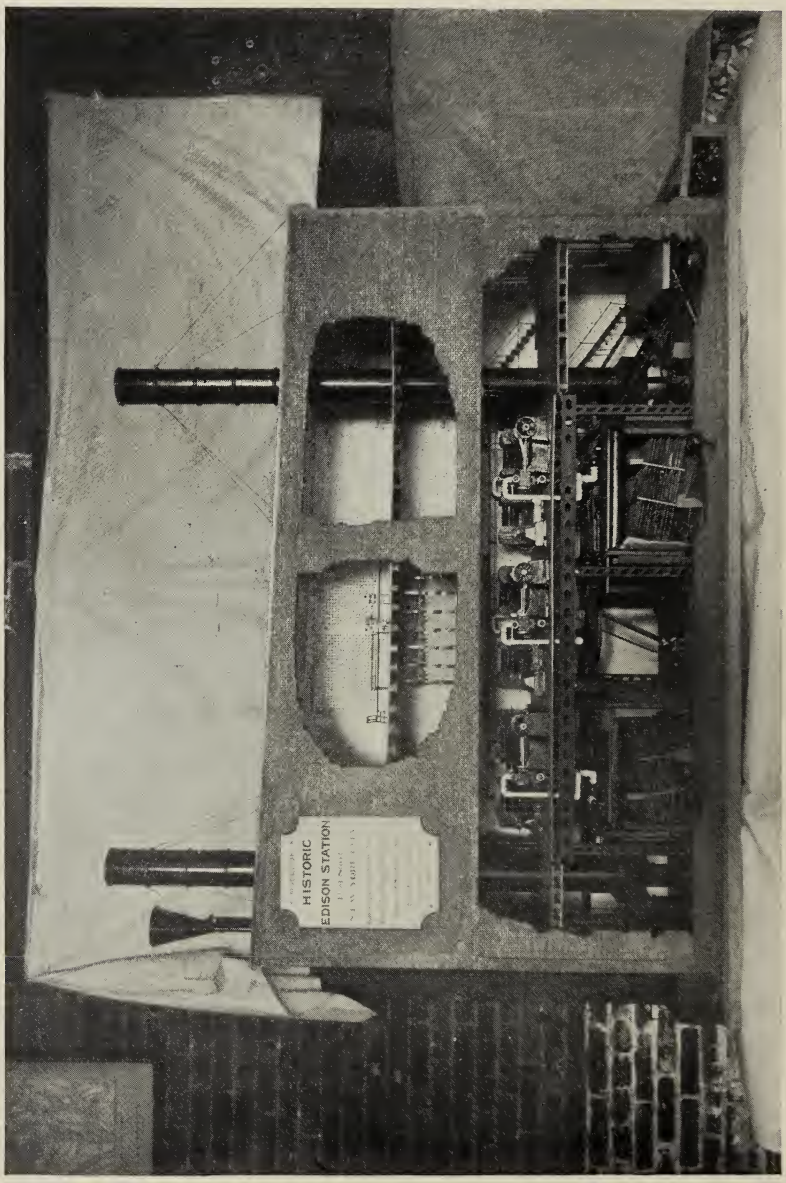
DYNAMO ROOM

ERRATUM:

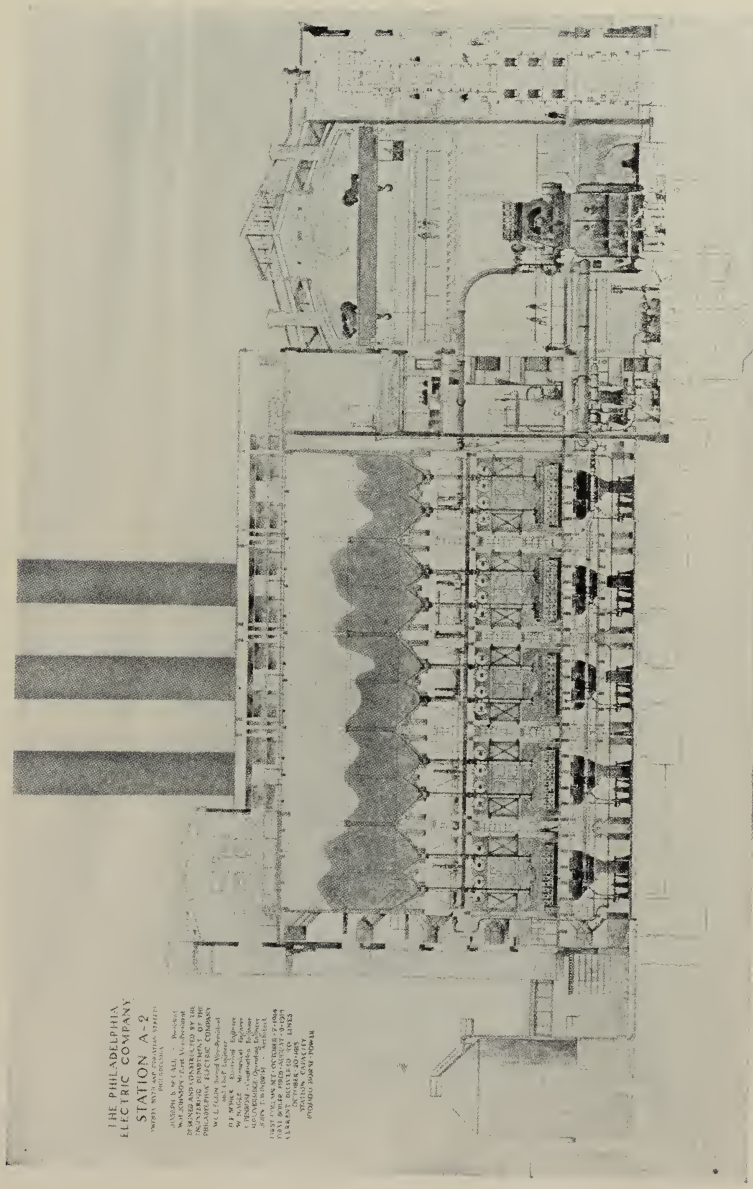
Fifth paragraph on page 34 should read as follows:

Shortly previous to this time, Frank J. Sprague undertook the construction of the Richmond (Va.) Union and the St. Joseph (Mo.) Union Passenger Railways; this was in the spring of 1887. The former of these installations is recognized as *the pioneer of the modern trolley.* Mr. Sprague in 1882 had conceived the overhead trolley and in 1885 had invented the wheel-barrow suspension for electric railways, and in the same year had proposed that the elevated railroads (then steam driven) be equipped with motors carried on the trucks. Such tests were made in 1885-86.

The multiple-unit control system for railway service was invented in 1895 by Mr. Sprague, was proposed by him for the Elevated Railroad in New York in 1896 and 1897, and first commercially adopted on the Chicago South Side Elevated Railroad in the latter year. This system of control, which has since become of the most vital importance in coping with the problems of modern transportation, gave the transportation industry an added impetus and greatly stimulated its growth. The system is now used on all electric railways where two or more locomotives or car units are under a common control.



AMERICAN PRACTICE—1882: SECTION OF PEARL STREET STATION
NEW YORK EDISON COMPANY—*From a Model*



AMERICAN PRACTICE—1915: SECTION OF STATION "A-2," THE PHILADELPHIA ELECTRIC COMPANY

THE INTERNATIONAL ELECTRICAL EXHIBITION BUILDING, PHILADELPHIA

THIS building, which was situated near Thirty-second and Market Streets, Philadelphia, housed the International Electrical Exhibition, the first of its kind ever held. The Exhibition, which was under the auspices of the Franklin Institute, opened September 2, 1884; it was held "for the Promotion of the Mechanical Arts."

The amount and variety of the apparatus gathered together for the exhibition were extremely large and showed what progress the electrical art had made, even up to the year 1884, which was two years after the establishment of the *First Central Station.*

A skeleton outline of the General Classification of Exhibits, follows:

SECTION I.—PRODUCTION OF ELECTRICITY: Very comprehensively included exhibits of apparatus for producing electricity by friction, voltaic and thermal means, as well as by dynamo-electric machinery. Steam boilers, engines, and gas engines were also exhibited with their accessories.

SECTION II.—ELECTRIC CONDUCTORS: Included wires and cables for transmission of power and intelligence, together with accessories such as conduits, ducts, insulators, joints, etc.

SECTION III.—MEASUREMENTS: Instruments for measuring physical properties and quantities, and electrical quantitative units were exhibited.

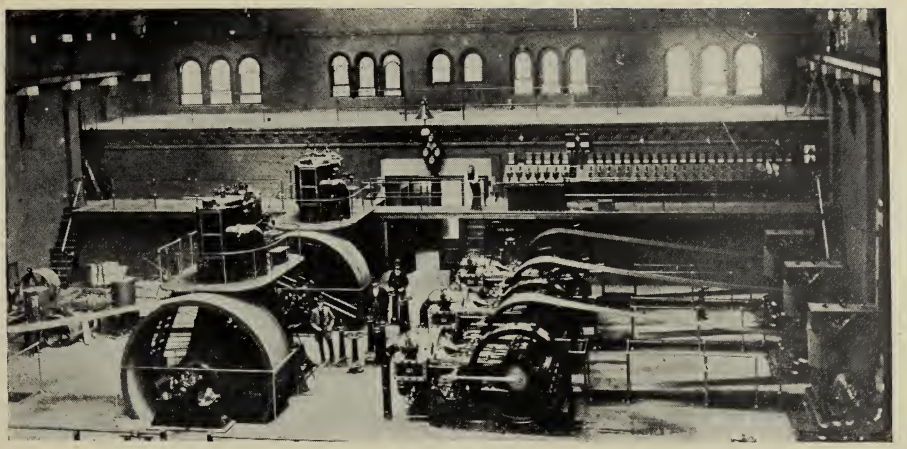
SECTION IV.—APPLICATIONS OF ELECTRICITY: This section was divided into two parts, one of which included apparatus using small currents, such as telephone, telegraph, burglar alarms, clocks, etc. The other embraced apparatus requiring heavy currents, such as lamps, motors, plating machines, etc.

SECTION V.—TERRESTRIAL PHYSICS: Apparatus for measuring atmospheric and terrestrial magnetism and electricity.

SECTION VI.—HISTORICAL APPARATUS: Many interesting and important historical apparatus were exhibited under this head.

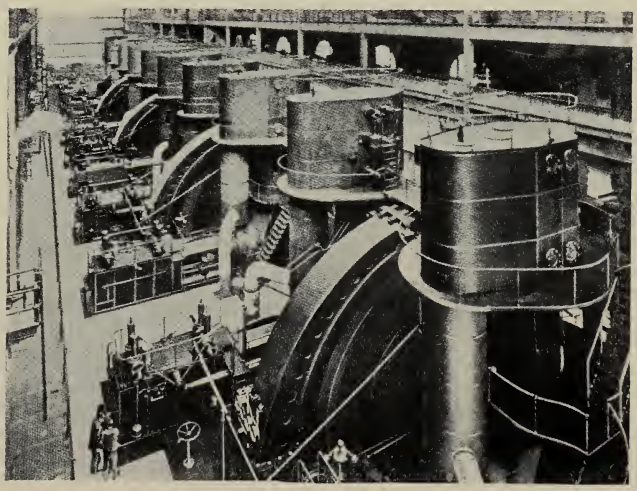
SECTION VII.—MISCELLANEOUS.

SECTION VIII.—EDUCATIONAL AND BIOGRAPHICAL: Exhibits of books, models, and other educational material.



1893 (CIRCA)

THE EVOLUTION OF AN EARLY STATION



1903

59th STREET STATION OF I. R. T. CO., NEW YORK CITY

FIVE OF THE NINE 12,000 H. P. HORIZONTAL-VERTICAL TYPE DIRECT-CONNECTED ENGINE-DRIVEN GENERATORS

THE COURT OF HONOR

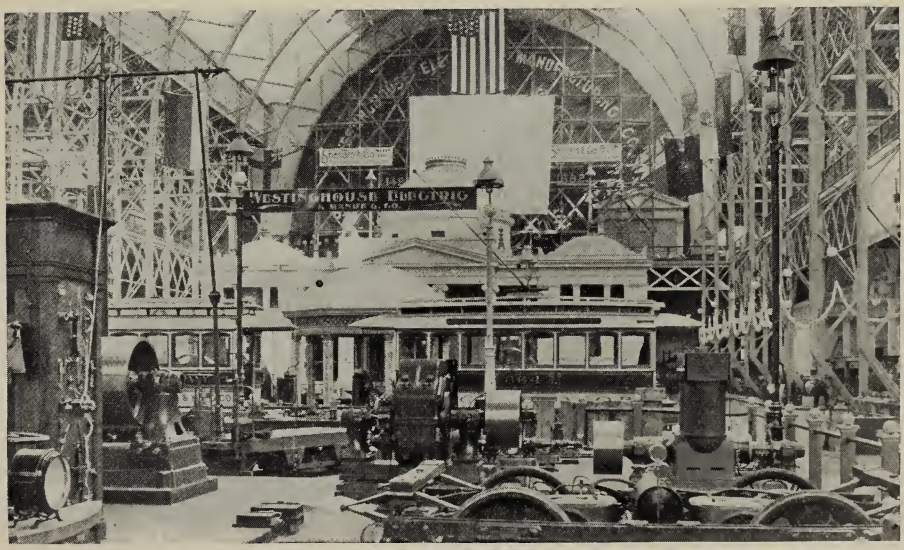
ELECTRICITY AT THE WORLD'S COLUMBIAN EXPOSITION, CHICAGO, 1893

ALTHOUGH the Electrical Exhibit was only a part of the World's Columbian Exposition in 1893, it surpassed by an amazing amount all previous Electrical Expositions or Exhibits given in this country or elsewhere. The tremendous progress which the Art had made in the period immediately preceding the exhibition was of an intensely interesting character.

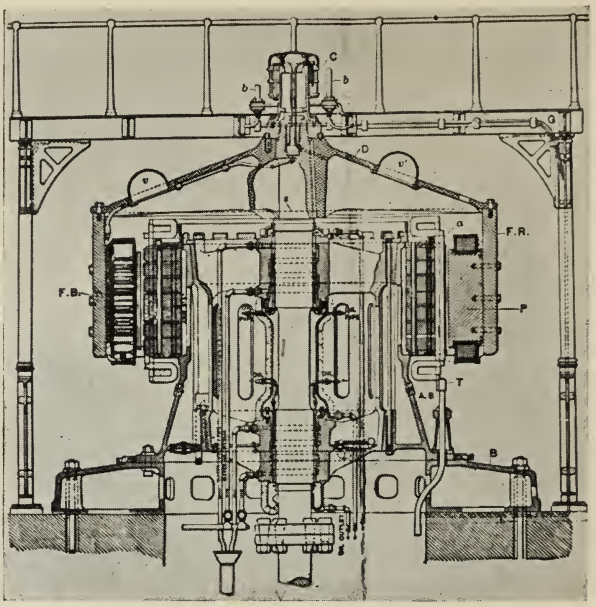
Electricity for the first time (in World's Fairs) played an important part in the conducting of the Exposition itself. Of course, the illumination of all the buildings and grounds was electrical. No less than 66,000—16 c. p. incandescent and 525 Helio arc lamps, for that day an *unheard of* amount, were used for building and grounds lighting. In addition, electricity was used as the sole means of transportation, both on the railways and waterways, and for all power purposes in the Exposition.

The Electrical Exhibits themselves were extensive, and represented all the leading manufacturers of the World. Among the material exhibited were: many types of lamps, arc and incandescent; power house equipment, generators, instruments, switchboards, etc.; motors, primary and secondary batteries; railway, motive power and signal equipment; telephone, telegraph, fire and burglar alarm systems, the application of electricity to chemistry, mining, iron manufacture, medicine, naval service and many other miscellaneous uses.

"DEPARTMENT OF ELECTRICITY" BUILDING



MAIN EXHIBITION HALL



NIAGARA FALLS GENERATORS—1895

"THE 5000-horse-power alternators are now being placed on their foundations in the power house. The wheel pit is arched over to form the floor of the power house and a cement floor has been laid thereon.

"The two circular cast iron bases mounted upon the stone foundation as shown are ready to receive the stationary armature which is bolted to a vertical cast iron cylinder. The mechanical construction of these alternators *is practically the same as designed by Prof. Forbes,* but the electrical work and details of winding are said to have been modified by the Westinghouse Electric & Manufacturing Company.

"The alternators, which are 13½ feet high, each generate two alternating currents differing in phase from each other by 90 degrees, with a frequency of 25 periods per second. The current conducted through each circuit is designed to be 775 amperes at a potential of 2250 volts. The field coils consist of bent copper bars which receive the current from rotary transformers by means of brushes and copper rings fixed to the shaft which supports the field magnets. The speed of the revolving magnets is 250 revolutions per minute, and the turbine is said to be so designed that the maximum speed possible will be less than 500 revolutions per minute."

—From *Electrical World*, FEBRUARY 9th, 1895

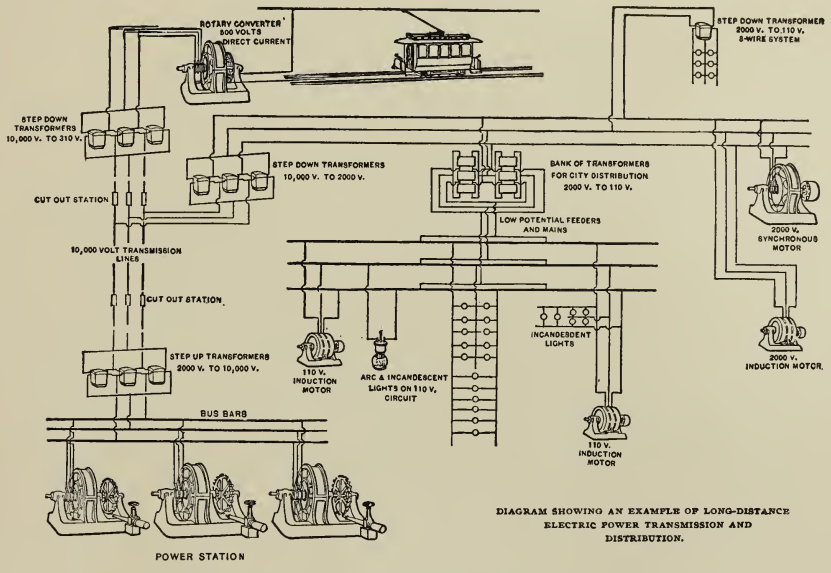


DIAGRAM SHOWING AN EXAMPLE OF LONG-DISTANCE ELECTRIC POWER TRANSMISSION AND DISTRIBUTION.

AN ENGINEERING PROPHECY MADE IN 1895

"The illustration *above* shows, diagrammatically, the connections of a long-distance transmission such as that to be installed from Niagara to points sixty miles or more distant. Its distinguishing engineering features, and those which will mark a departure from anything heretofore attempted, are: The size of the units (generators, motors, and transformers); the solidity and strength of line construction, and the electro-motive force, or electrical pressure used on the line. The last feature is the only one that presents any unknown quantities, and it is really the one which will determine the engineering limit of the distance over which it will be possible to transmit a given amount of power from Niagara.

"From experiments and tests already made on the Lauffen-Frankfort line, and elsewhere, *it does not seem hazardous to predict that a maximum pressure of 50,000 volts at the delivery end of the line will be successfully adopted for long distances*, if business conditions warrant the transmission. It is interesting to observe that in the transmission of either oil, gas or electricity, the limiting engineering condition is, in each case, the line pressure that can be safely carried."

—From Article by the late S. DANA GREENE, in *Cassier's Magazine*, July, 1895

COMPARE THE ABOVE WITH PLATE I, FACING PAGE 53

rendered the Industry was the construction of measuring instruments. The electrical instrument field, when he entered it, was bare of anything but the crudest make-shifts and laboratory apparatus. He designed, constructed and manufactured the *first really good* instruments, and built up a tremendous business in what then appeared to be a small corner of the Industry.

In 1893, the Commission of consulting engineers for the new Niagara Power House decided, after much debate, to use alternating current for the system. The question of frequency was an open one for some time, and was the subject of a good deal of controversy. Finally, as water turbines of 250 r. p. m. had been ordered, the choice lay between 25 and 33 1-3 cycles. The commission chose the former. This choice had far-reaching influence and led to the adoption of 25 cycles as a standard frequency in the United States, for power purposes.

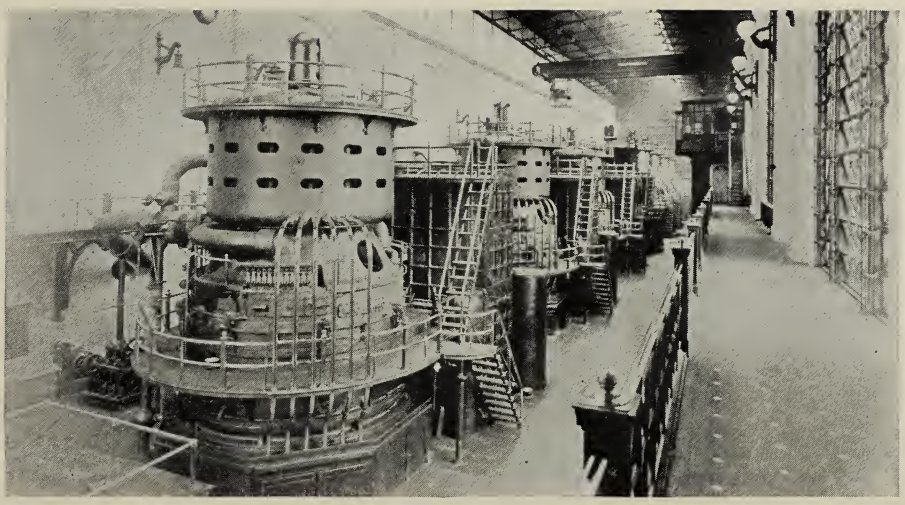
In 1894, an alternating-current system known as "monocyclic" was introduced by the General Electric Company as a competitor of the Tesla polyphase system. The former, due to its greater complication, was never widely introduced.

The Niagara generators, built in 1895, had several features making them worthy of note. These generators were the first practical machines to have stationary armatures and revolving fields. This end was accomplished, not as it is today by a field revolving *inside* the armature, but by a massive field structure revolving *outside* the armature. This was known as the "umbrella type" and was the intermediate step between the old revolving armature machine and the modern form of revolving field machine.

The year 1896 saw an important step in development, namely, the acquisition by George Westinghouse, of the manufacturing rights of the Hon. Charles H. Parsons for his steam turbine; but it was not until the year 1899 that the Westinghouse Company installed any of these turbines. The first, three in number, which were installed for commercial use, were placed in the plant of the Westinghouse Air Brake Co., and had a capacity of 400 kw. each. From that initial installation the turbine industry grew, slowly at first and then extremely rapidly as the tremendous advantages of this type of prime-mover became realized. To the Hartford (Conn.) Electric Light Company belongs the honor of installing the FIRST TURBINE OF ANY CONSIDERABLE SIZE FOR POWER COMPANY USE. Their unit, installed in 1900, was 1,500 kw. capacity, and built by the Westinghouse Company.

The Commonwealth Edison Company, of Chicago, in 1903 put into operation its Fisk Street Plant, which was the FIRST ALL-STEAM-TURBINE-ELECTRIC-GENERATING PLANT in the history of the Industry. The turbines installed were Curtis, made by the General Electric Company.

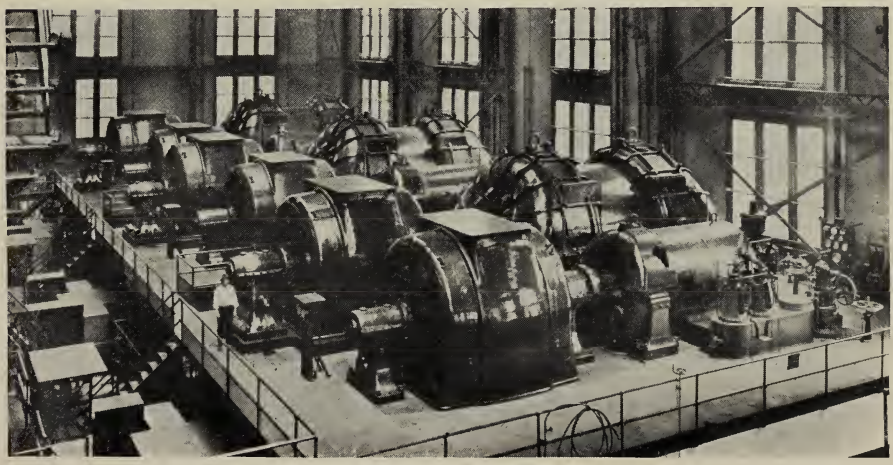
Continued on page 46



1903

FISK STREET STATION, CHICAGO

IN THE FOREGROUND IS THE 5000 K.W. TURBINE SHOWN ON PAGE 47



1916

74th STREET STATION, I. R. T. CO., NEW YORK CITY

THREE 30,000 K.W. "CROSS-COMPOUND" UNITS

The tremendous progress which turbines were making at that time is shown by the fact that these units within a few years were scrapped to give way to a more efficient type. One of the original 5,000-kw. units is shown on page 47; it is already serving as a monument to this epoch-making installation, at the works of the General Electric Company, Schenectady, U. S. A.

Dr. Whitney and his able co-workers in 1906 helped to bring about the introduction of the tungsten metal-filament lamp, producing several times as much light per watt as did the carbon lamp, then generally used. It was predicted that this cheap light would curtail Power Company earnings. For the first year after its introduction the pessimists had the better end of the argument, but then the *"average man"* yielded, as the psychologists had predicted, and purchased more candle power than he ever had before, because he could get it cheaper!

In 1906 the New York Central started their electrification, which in 1907 was followed by the electrification of the New York, New Haven and Hartford Railroad. These installations marked a new era in the application of electric service to transportation.

The development of the turbine and its increased application, which had been going on steadily since its inception, passed a prominent milestone in 1911, when the New York Edison Company installed a 20,000-kw. unit in its Waterside Station No. 1. This large and important installation was surpassed four years later when The Philadelphia Electric Company placed a 35,000-kw. unit in commission in its Station "A-2." Each of these units was the largest in operation in the world when installed, and even today (February, 1917), the latter has the distinction of being the largest in service.

The year 1915 saw very marked development in several lines, among which were the placing in service of the Pennsylvania Railroad terminal electrification at Philadelphia; and of an altogether different nature, the illumination at the Panama-Pacific Exposition, which was regarded as the most important installation yet achieved.

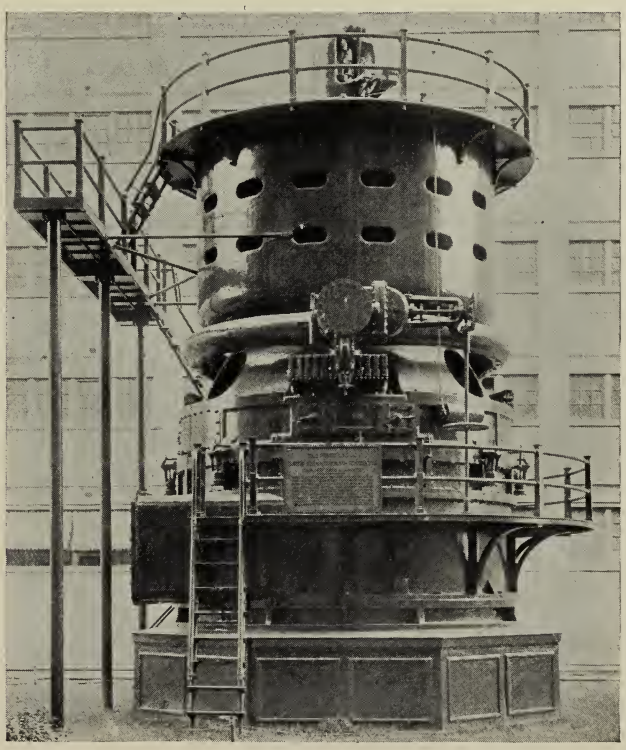
It is hardly necessary to state that in presenting the foregoing historical outline, I can make no claim whatsoever to completeness, but have merely covered what seemed to me as being high spots in and related to the development of the Industry.

As you have seen, starting with the most primitive plant equipment (the units in the earlier power houses were from 25 to 50 horse-power, and employed non-condensing engines), and starting with an equally primitive company organization, the MODERN POWER COMPANY has come to take its place as one of the most important factors in the community which it serves, equipped with plant equipment having efficiencies and capacities

Continued on page 49

A MONUMENT TO THE TURBINE INDUSTRY IN AMERICA

ERECTED IN YARD OF SCHENECTADY WORKS
OF · THE · GENERAL · ELECTRIC · COMPANY



THE FIRST LARGE
CURTIS STEAM TURBINE-GENERATOR
Capacity 5000 Kilowatts

This machine was designed and built by the General Electric Company for the Commonwealth Edison Company and was operated in the Fisk Street Station Chicago, from October Second, 1903, until May Twenty-ninth, 1909, when it was replaced by a Curtis Turbine-Generator of greater capacity. It was, when installed, the largest steam turbine in existence.

—From Tablet placed on Turbine Casing

SINCE THE INSTALLATION OF THIS HISTORIC TURBINE, 1903, AMERICAN MANUFACTURERS HAVE TURNED OUT AN ESTIMATED CAPACITY OF 9,500,000 KILOWATTS IN STEAM-TURBINE-ELECTRIC-GENERATOR SETS!

"THE ILLUMINATION AT THE PANAMA-PACIFIC EXPOSITION, 1915, WAS REGARDED AS THE MOST IMPORTANT INSTALLATION YET ACHIEVED"

undreamed of even two decades ago, and with a company organization that includes a personnel in which almost every man is a trained specialist.

The reasons for the remarkable growth are simply expressed, namely, the progressively increasing economies secured when electrical energy—now the recognized agency for the transmission of energy and the production of light—is generated and distributed on a large scale.

The factors which have produced these progressively increasing economies are:

First: The high efficiency of dynamo-electric machinery, enabling mechanical energy to be transformed into electrical energy with small loss. The efficiency of even very small machines is 80 per cent., and in the larger machines upwards of 95 per cent.

Second: The ability to transmit this energy over long distances at high efficiency, and by means of simple and relatively inexpensive construction.

Third: The development of the incandescent lamp which has been evolved from the old carbon filament lamp, having an efficiency of three to four watts per candle-power, to the modern tungsten filament lamp, whose efficiency is approximately one watt per candle-power.

Fourth: The development of the steam turbine, which in the larger sizes has a steam rate at least 50 per cent. lower than that of the steam engine.

Fifth: The lower investment cost for turbo-generator units in the larger sizes.

Such development as the Power Company has experienced is probably unprecedented in the history of industrial expansion.

So much for the industry's past history and the reasons for its growth.

THE FIELD OCCUPIED BY THE POWER COMPANY TODAY

SECTION III:

THE field occupied by the Power Company can be considered under the heads of Scope, Service and Public Relations.

SCOPE and SERVICE are so closely allied that I will consider them together.

In this day of specialization, the Power Company, being the factor in the community which specializes in the manufacture of electrical energy, if it is to justify its economic reason for existence, logically should *supply electrical energy for every purpose for which electricity may be required* in the community which it serves. This is a pretty sweeping assertion, but one which the larger companies already are prepared so far as equipment is concerned to follow out, and to some of them the realization is approaching.

In other words the scope of the power company is unlimited in its particular territory.

As regards PUBLIC RELATIONS:

That the absolutely self-evident waste in the duplication of equipment when two power companies operate in the same community may be avoided, monopoly is essential. But on the other hand, in order that both the public and the company shall be protected in their interests *and shall be in mutual understanding,* it is quite equally essential that it shall be a *regulated* monopoly. The only proper agency under whose jurisdiction the regulation should come is the Commonwealth itself, within which the monopoly operates.

Public service commissions now are part of the Commonwealth's administrative machinery in almost every State in the Union, and when this body deals in strict fairness to both sides, the mutual benefit is beyond question of doubt. All rate schedules, capitalization plans and other matters in which public and company are mutually affected are submitted for ratification, and such files are kept open to the public at all times. Such a condition of affairs did not exist at the inception of the Industry.

Granted then, that we have a justly regulated public utility monopoly—the Power Company—operating in a given community, the force of the very logic against the so-called "isolated" plant seems irresistible, from the Power Company's point of view! But what is more to the point, the Power Company is going to the owner of the isolated plant and proving to him a saving in the use of central station service—with the result that the isolated plant is disappearing.

The case against the isolated plant is of course an economic one—otherwise it would not hold—and it is just this, due to the factor of diversity in the use of electrical energy in a community, the *maximum* demands do not come *coincidently* for all users of electricity in the community. The periods of maximum demand on the part of various classes of users differ from one another in the time of day, and some in the time of year. The net result is a reduction in the cost of energy and a large saving in investment, when the supply is from a centralized source, for the reason that each individual customer otherwise would have to install equipment to meet his individual maximum demands, and the *total* plant investment in the community would be greatly in excess of that required by the power company. Furthermore, the smaller apparatus cannot be operated at the same economy.

In its public relations, then, the Power Company has come to be recognized as one means of conserving our natural resources and adding to the economic and general welfare of the community. The American power companies as a whole have added tremendously to the economic wealth of the nation.

HOW THE POWER COMPANY DISTRIBUTES ELECTRICAL ENERGY · PLANT PROPERTY AND APPARATUS

SECTION IV:

THE best practice in Steam Power Company engineering today utilizes a small number of very large capacity central generation stations. These stations contain steam-turbine electric generators exclusively, generating polyphase alternating currents usually at pressures in the neighborhood of 13,000 volts. At this pressure energy is distributed directly from the generating stations, through underground cables, into a network of sub-stations, geographically distributed throughout the area served by the Power Company, at locations which form the centers of load in the various districts. Distribution at reduced pressures to customers is accomplished from the sub-stations, and will be either direct current to the older, central districts, or alternating current to the other districts.

The generating stations themselves are connected by tie lines, enabling the interchange of energy from one to another. In the case of distant generating stations, the potential of 13,000 volts suitable for metropolitan transmission is "stepped-up" to higher potentials, and the overhead tie lines run on steel towers on a special right-of-way.

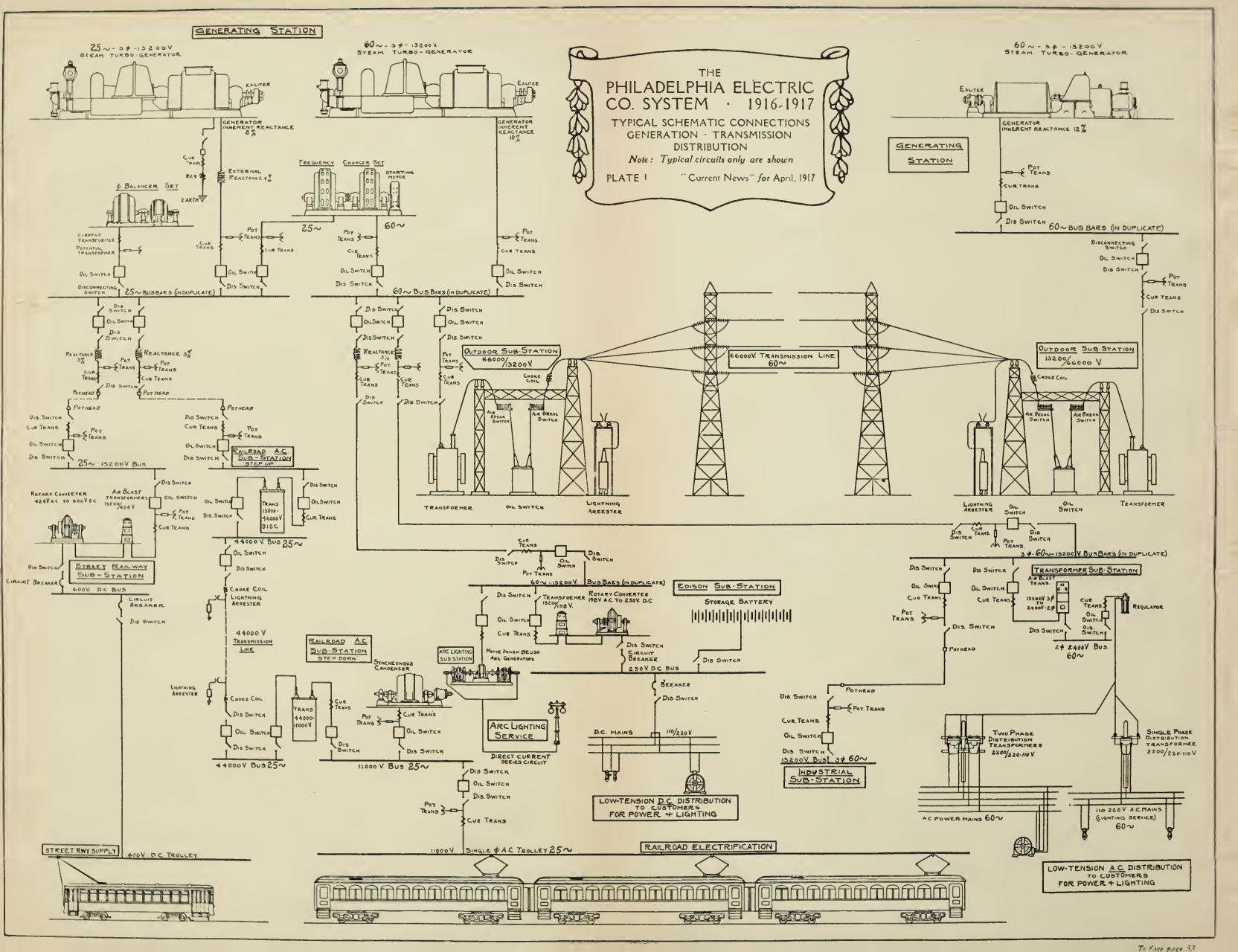
Two frequencies are employed: 25 cycles for railroad electrification and traction system supply, and 60 cycles for all other power and lighting supply.

Frequency-changer equipment is maintained to serve as a tie between the two systems for the exchange of energy in either direction.

As regards boiler plant equipment, large-capacity high-pressure units of high efficiencies are installed, of the water-tube type, equipped with automatic stokers and with provision in coal bunker capacity, etc., to insure a continuity of fuel supply.

The power plant buildings proper are divided between boiler house, turbine hall and switch house, the latter usually being a separate building, isolated from the rest of the plant and containing all electrical switching and control equipment.

With the installation of large-capacity units of high efficiency, the plant attendance costs have been materially reduced per *kw.-hr.* output, over what was necessary in the earlier small stations. Present-day power companies can well afford to include as a part of their permanent organization, engineering specialists whose sole duties are to watch and improve the overall economies of the generating stations. Here it is that the greatest



To Face page 53

economies can be secured, and this is being followed in American practice today.

The successful development of steam and electric measuring and recording devices, perfected by the manufacturers in large part at the demand of the Power Companies, has rendered possible what is practically a continuous "plant test."

I propose to show you diagrams and views of large-capacity plant electrical equipment, which are typical of the best American practice for Power Companies serving large metropolitan territories and the adjoining smaller cities, including the supply to railroad electrification and urban, suburban and interurban traction lines.

The system which I have taken as typical, is that of The Philadelphia Electric Company and its subsidiary companies.

This will be followed by data and views of representative American power stations, from coast to coast.

To adequately describe the Philadelphia system, I wish to call your attention to PLATE I, facing page 53.

This plate shows diagrammatically the whole layout of the system, including generating stations, distributing lines, sub-stations and customers. The diagram has been prepared to show *typical* circuits only, *i. e.*, it illustrates *one* of every type of sub-station and *one* of every type of customer. Details have been consistently omitted.

The general arrangement of the diagram is as follows: At the top are shown the generating stations, and lower down the sub-stations and customers. You will notice that the generating station in the upper left-hand corner contains generators of both 25- and 60-cycles. The feeders from the 25-cycle system lead to urban and interurban street railways; also to the Pennsylvania Railroad electrification, which is a single-phase load. The presence of *large single-phase loads* on the 25-cycle system makes a *phase-balancer* desirable, in order to utilize the full capacity of the *polyphase generators.*

The 60-cycle system has no predominately large single-phase loads, consequently the phase-balancers are omitted from that system.

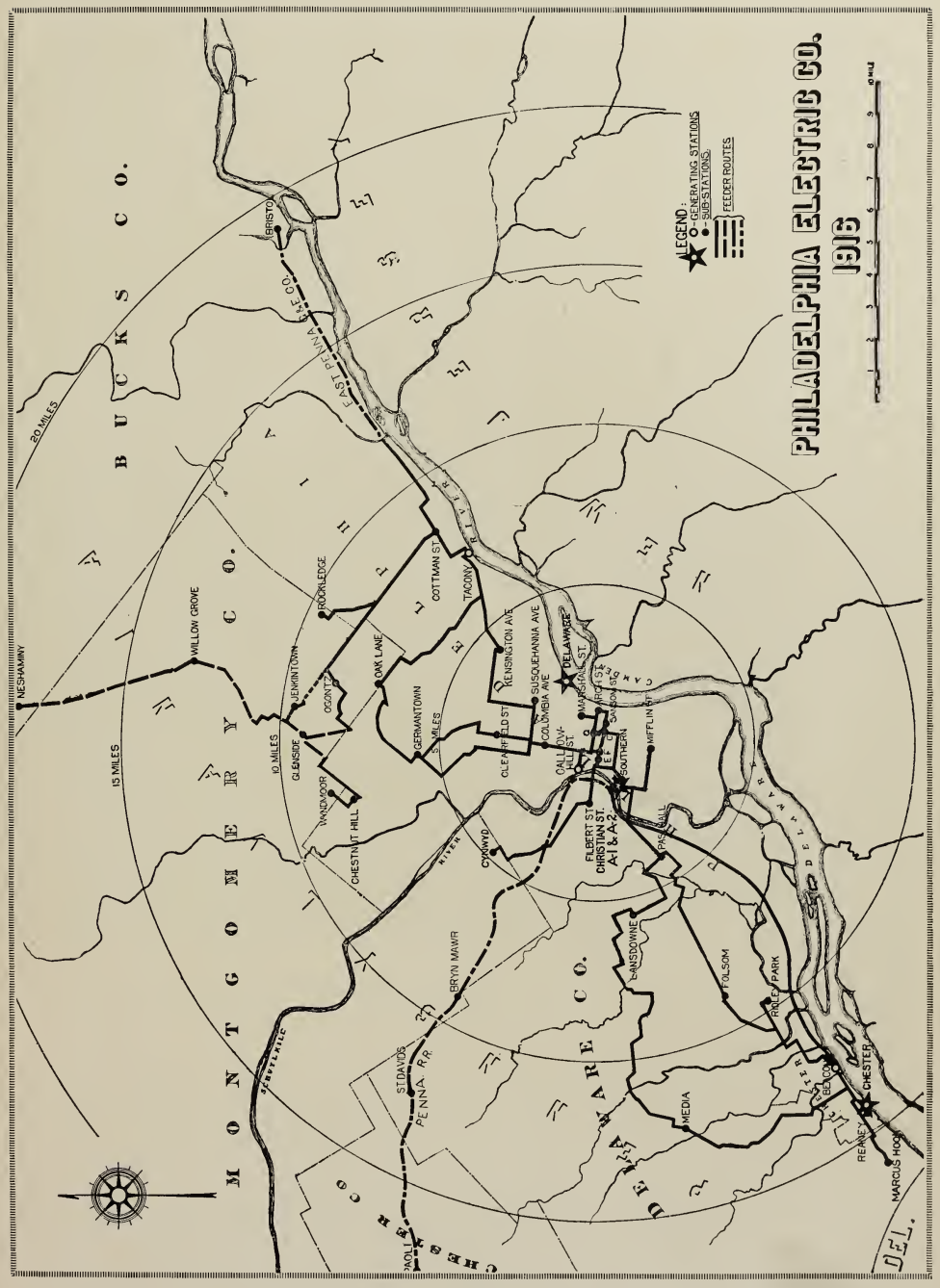
The 25- and 60-cycle systems are independent, except for the frequency-changer sets. This apparatus couples the two systems together, enabling an interchange of energy to take place; for example, should reasons of economy or reliability make it desirable, the 25-cycle buses may be fed from the 60-cycle generators or *vice-versa.*

Another feature of the system designed to promote continuity of service is the duplicate sets of bus bars installed throughout the generating stations, and in the important sub-stations.

The generating station in the upper right-hand corner is geographically located sixteen miles from that in the left-hand corner. The location of the former is desirable for engineering and economic reasons and the intervening distance is spanned by a 66,000-volt transmission line.

The many types of sub-stations needed to suit the varied requirements of the industrial activities of a large center of population are shown. The large variety of requirements for different *kinds* of energy, which it is true is not desirable from an engineering standpoint, has arisen from the fact that the early installations were in no way uniform. To meet these needs, the several types of sub-station have been developed.

The map on page 55 indicates the extent of the territory served by the Philadelphia system.


PHILADELPHIA ELECTRIC CO.
1916
LEGEND:
GENERATING STATIONS
SUB-STATIONS
FEEDER ROUTES
BUCKS CO.
MONTGOMERY CO.
DELAWARE CO.
CHESTER CO.
DELPHIA
20 MILES
15 MILES
10 MILES
NESHAMINY
WILLOW GROVE
JENKINTOWN
OGONTZ
GLENSIDE
WANDMOOR
CHESTNUT HILL
ROCKLEDGE
OAK LANE
GERMANTOWN
COTTMAN ST.
TACONY
KENSINGTON AVE
SUSQUEHANNA AVE
COLUMBIA AVE
CLEARFIELD ST
DELAWARE
MARSHALL ST.
SANSOM ST.
MIFFLIN ST.
SOUTHERN
CALLOWHILL ST.
FILBERT ST.
CHRISTIAN ST.
A-1 & A-2
PASSAIL
CYNWYD
BRYN MAWR
ST. DAVIDS
PENNA. RR.
LANSDOWNE
FOLSOM
RIDLEY PARK
MEDIA
BEACON
CHESTER
REANEY
MARCUS HOOK
BRISTOL
EAST PENNA. R.R. CO.
RIVER
DELAWARE
SCHUYLKILL
DEL.

TYPICAL AMERICAN POWER C

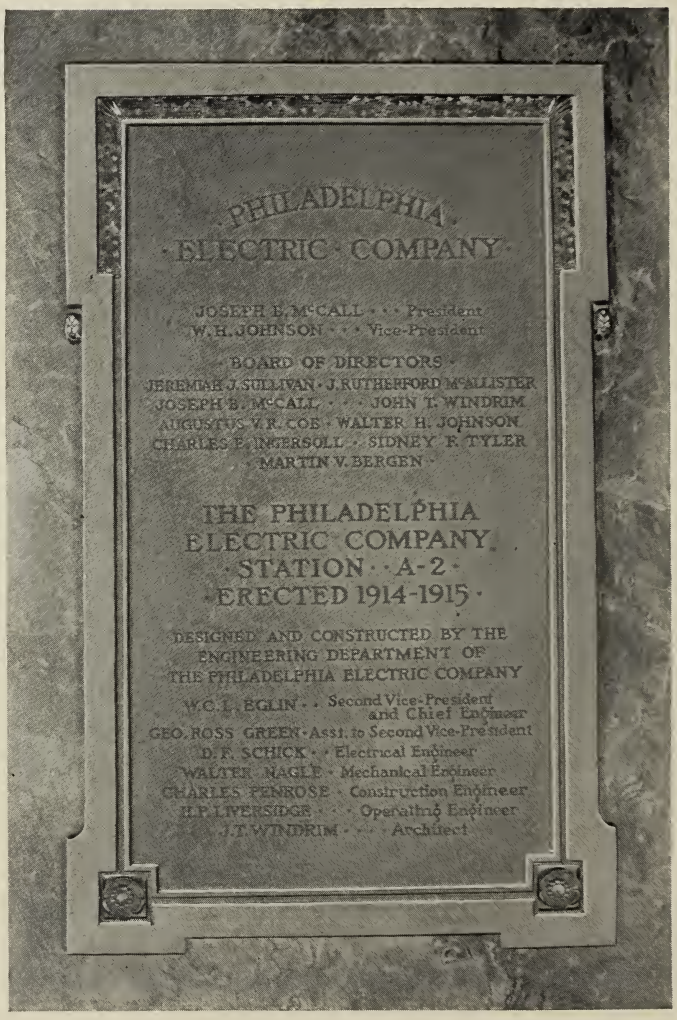
CHESTER · WATERSIDE · STATIC

ULTIMATE CAPACITY · 120,000 KILO-WATTS · · · 30,000-K.W. S

MPANY GENERATING STATION

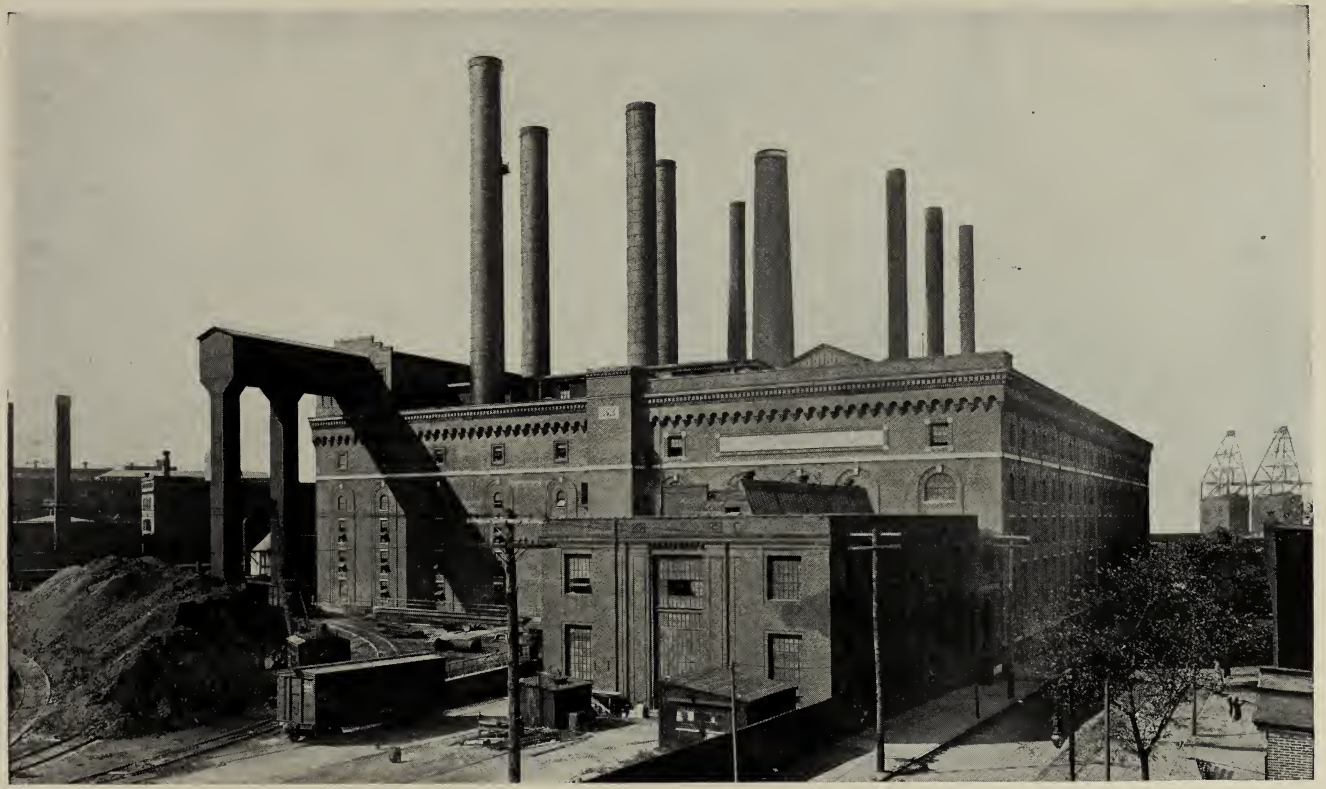
· · CHESTER · PENNSYLVANIA

M TURBINE UNITS · · STATION UNDER CONSTRUCTION — 1917

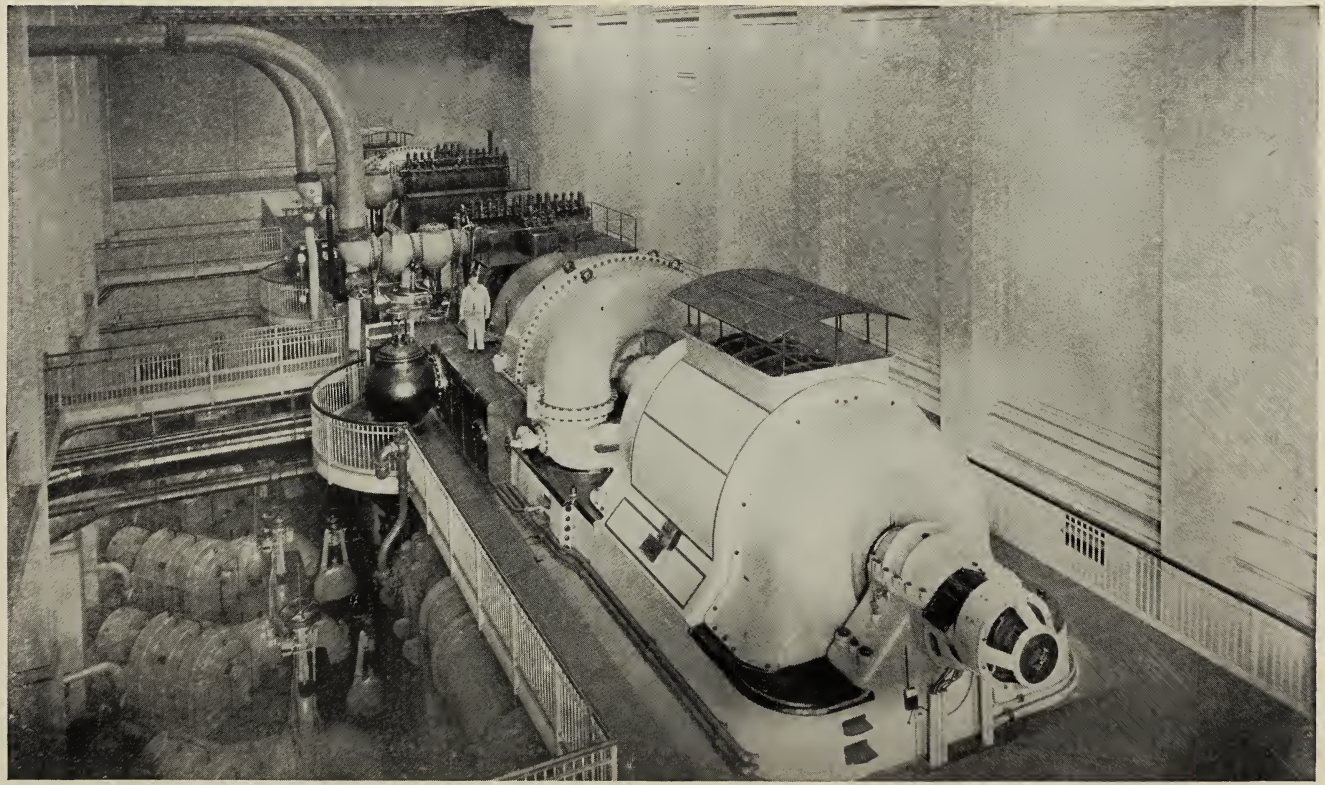


"THE BUILDERS OF STATION 'A-2'"

A BRONZE TABLET ERECTED IN THE PLANT



STATIONS "A-2" (in foreground) AND "A-1", 26th TO 28th AND CHRISTIAN STREETS, PHILADELPHIA
COMBINED GENERATING CAPACITY (1916): 150,000 KILOWATTS



STATION "A-2", PHILADELPHIA

30,000-K. W. 25-CYCLE TURBO-GENERATOR IN FOREGROUND; 35,000-K. W. 60-CYCLE IN BACKGROUND
AT PRESENT THE WORLD'S LARGEST MACHINE

ARSENAL SUB-STATION, PHILADELPHIA

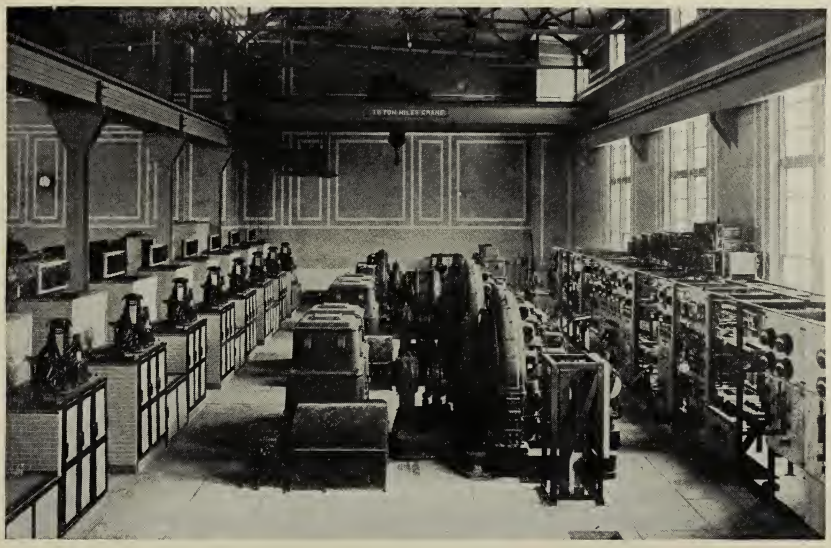
13,200-VOLT ENERGY FROM STATION "A-2" IS "STEPPED UP" IN THIS PENNSYLVANIA RAILROAD SUB-STATION AND TRANSMITTED AT 44,000 VOLTS TO THE RAILROAD'S SUB-STATIONS

PENNSYLVANIA R. R. ELECTRIFICATION

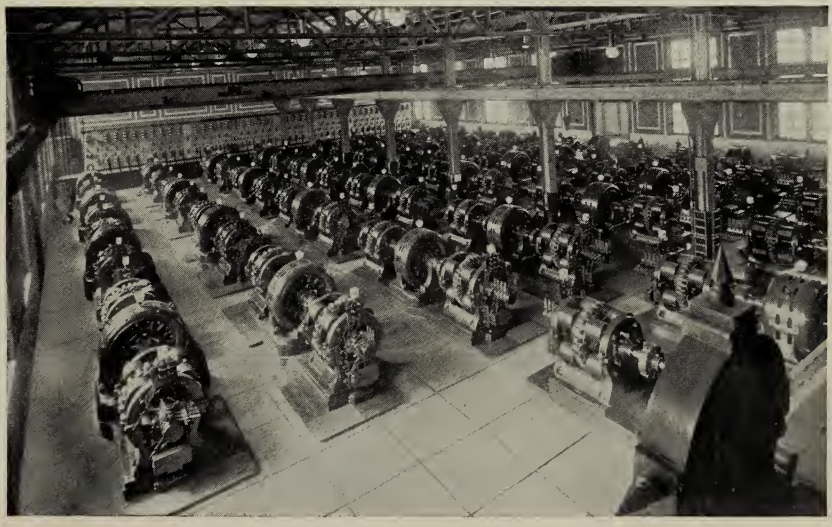
TYPICAL CONSTRUCTION ALONG THE MAIN LINE. SINGLE-PHASE ENERGY AT 11,000 VOLTS IS DELIVERED TO THE TRAINS FROM THE TROLLEY

CROSSING TOWERS (OVER SCHUYLKILL RIVER)
FOR THE 66,000-VOLT TRANSMISSION LINE BETWEEN STATION "A-2", PHILADELPHIA AND THE CHESTER WATERSIDE STATION, CHESTER, PENNSYLVANIA

FREQUENCY-CHANGER STATION: SUB-STATION "A", PHILADELPHIA



TYPICAL SYNCHRONOUS CONVERTER METROPOLITAN SUB-STATION
SUPPLYING A PART OF THE EDISON D-C DISTRICT—SUB-STATION "E", PHILADELPHIA



MOTOR-GENERATOR ARC LIGHTING SUB-STATION
SUPPLYING SERIES CIRCUITS IN MUNICIPAL STREET LIGHTING AND COMMERCIAL SERVICE
SUB-STATION "F", PHILADELPHIA

TYPICAL P. E. CO. SUB-STATIONS

SUB-STATION "F"

SUB-STATION "P"

PASCHALL SUB-STATION

CHESTNUT HILL SUB-STATION

THESE sub-stations, typical of American Power Company Practice, are designed for the most efficient distribution of electrical energy. Substantial buildings, proof, as nearly as human foresight can make them, against internal and external fires, equipped with modern, efficient and well-designed apparatus, are necessary to insure the community served of continuity of electrical service. Continuity of service being as it is the watchword of the Power Company is insured by using the best of brains, labor and material in the construction and operation of the sub-stations which are the "energy centers" of the system

REPRESENTATIVE AMERICAN POWER STATIONS

TYPICAL OF THE BEST POWER COMPANY PRACTICE
1917

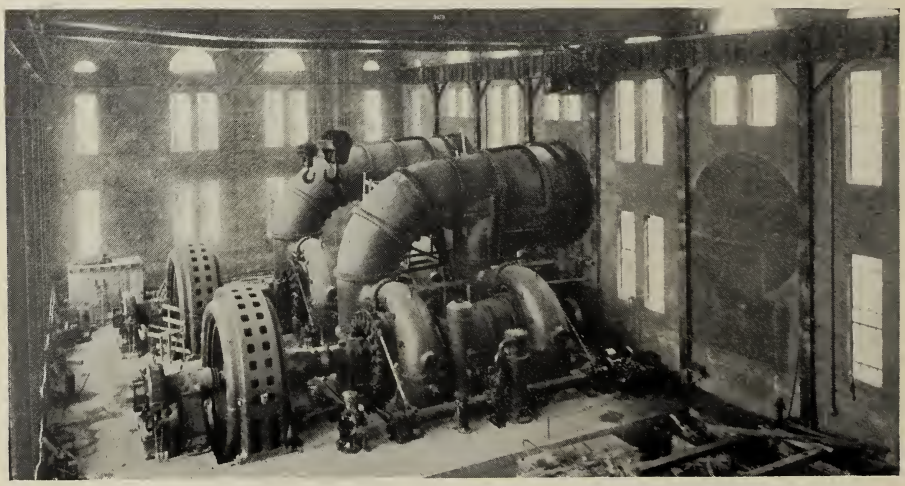
SPOKANE · WASHINGTON · SYSTEM

THE · WASHINGTON · WATER · POWER · COMPANY

NUMBER OF GENERATING STATIONS: 5 · COMBINED CAPACITY: 105,000 K.W.

OUTPUT (YEAR 1916): 162,800,000-K. W.-HR.

LONG LAKE POWER STATION ON THE SPOKANE RIVER



TURBINES AND GENERATORS IN LONG LAKE POWER STATION

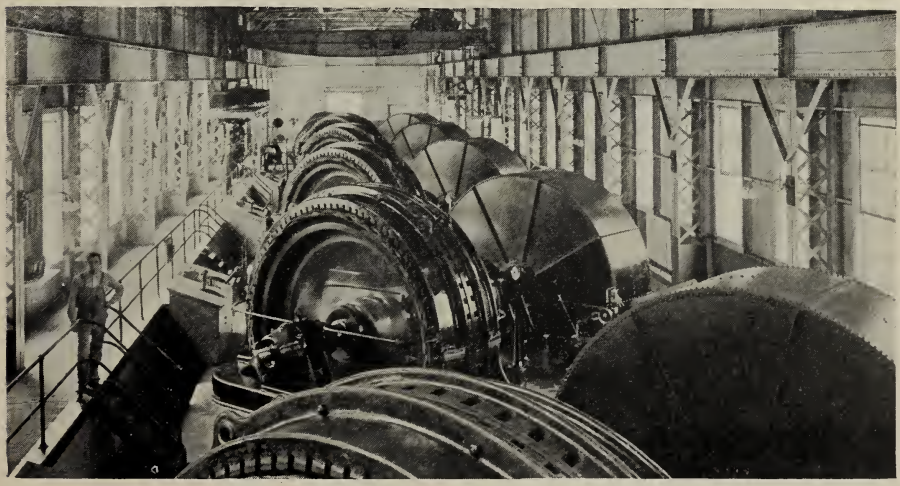
CENTRAL · CALIFORNIA · SYSTEM

THE · PACIFIC · GAS · AND · ELECTRIC · COMPANY

NUMBER OF GENERATING STATIONS: 14 · COMBINED CAPACITY: 195,150 K.W.

OUTPUT (YEAR, 1916): 768,300,000-K.W.-HR.

VIEW OF ELECTRA POWER HOUSE AND PIPE LINE



GENERATING ROOM OF THE ELECTRA POWER HOUSE

SOUTHERN · CALIFORNIA · SYSTEM

THE · SOUTHERN · CALIFORNIA · EDISON · COMPANY

NUMBER OF GENERATING STATIONS: 9 · COMBINED CAPACITY: 86,100 K. W.

OUTPUT (YEAR, 1916): 300,000,000-K. W.-HR.

KERN RIVER POWER PLANT

THE LONG BEACH STEAM POWER PLANT—OIL BURNING

CINCINNATI · OHIO · SYSTEM

THE UNION GAS AND ELECTRIC COMPANY

NUMBER OF GENERATING STATIONS: 3 · COMBINED CAPACITY: 95,000 K. W.

OUTPUT (YEAR, 1916): 104,300,000-K.W.-HR.

NEW STATION OF THE UNION GAS AND ELECTRIC CO. (UNDER CONSTRUCTION)
ULTIMATE CAPACITY: 240,000-K. W.

JOPLIN · MISSOURI · SYSTEM

THE HENRY L. DOHERTY & CO. INTERESTS

NUMBER OF GENERATING STATIONS: 52 · COMBINED CAPACITY: 206,000 K.W.

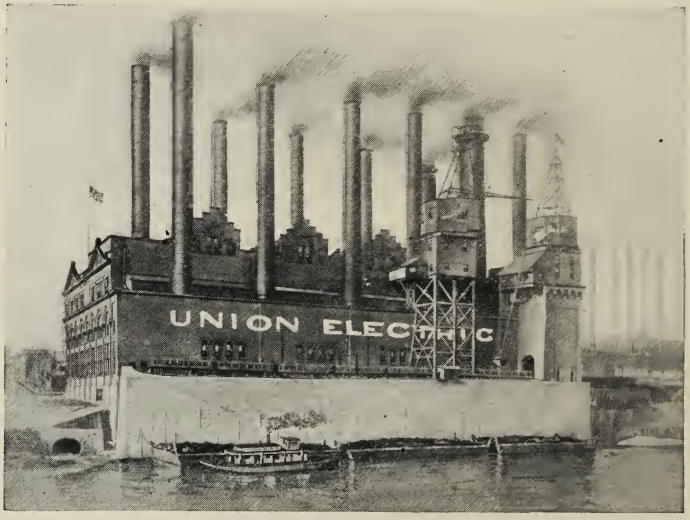
OUTPUT (YEAR, 1916): 553,900,000-K.W.-HR.

MAIN GENERATING STATION OF THE EMPIRE DISTRICT

ST. LOUIS · MISSOURI · SYSTEM

UNION ELECTRIC LIGHT AND POWER CO.

NUMBER OF GENERATING STATIONS: 1 · TOTAL CAPACITY: 116,000 K.W.
OUTPUT (YEAR, 1916): 200,000,000-K. W.-HR.



ASHLEY STREET STATION

CHATTANOOGA · TENNESSEE · SYSTEM

HALES BAR HYDRO-ELECTRIC DEVELOPMENT

POWER HOUSE AT HALES BAR

KEOKUK, IOWA, SYSTEM

THE MISSISSIPPI RIVER POWER COMPANY

NUMBER OF GENERATING STATIONS: 1 TOTAL CAPACITY: 111,000 K. W.

OUTPUT (YEAR 1916): 393,500,000-K. W.-HR.

THE KEOKUK POWER STATION SHOWING DAM

GENERATOR ROOM OF THE KEOKUK STATION

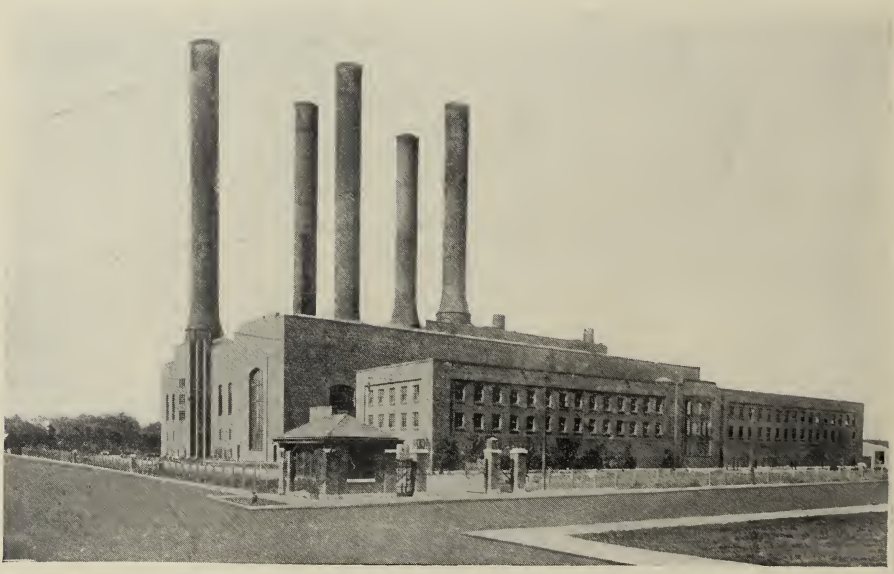
CHICAGO · ILLINOIS · SYSTEM

THE COMMONWEALTH EDISON COMPANY

NUMBER OF GENERATING STATIONS: 5 · COMBINED CAPACITY: 472,100 K.W.

OUTPUT (YEAR, 1916): 1,342,000,000-K.W.-HR.

PANORAMA OF FISK AND QUARRY STREET STATIONS



NORTHWEST POWER STATION

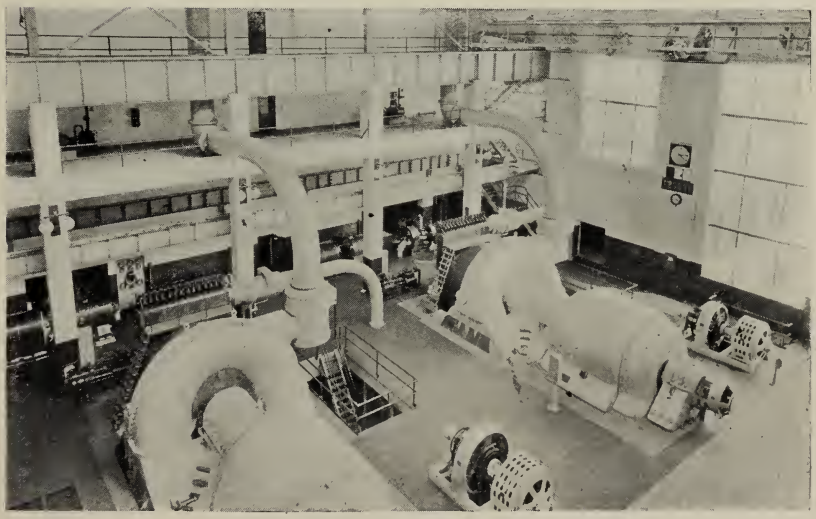
DETROIT · MICHIGAN · SYSTEM

THE DETROIT EDISON COMPANY

NUMBER OF GENERATING STATIONS: 7 · COMBINED CAPACITY: 154,075 K.W.

OUTPUT (YEAR, 1916): 562,000,000-K.W.-HR.

THE CONNORS CREEK POWER HOUSE



TURBINE ROOM, CONNORS CREEK PLANT

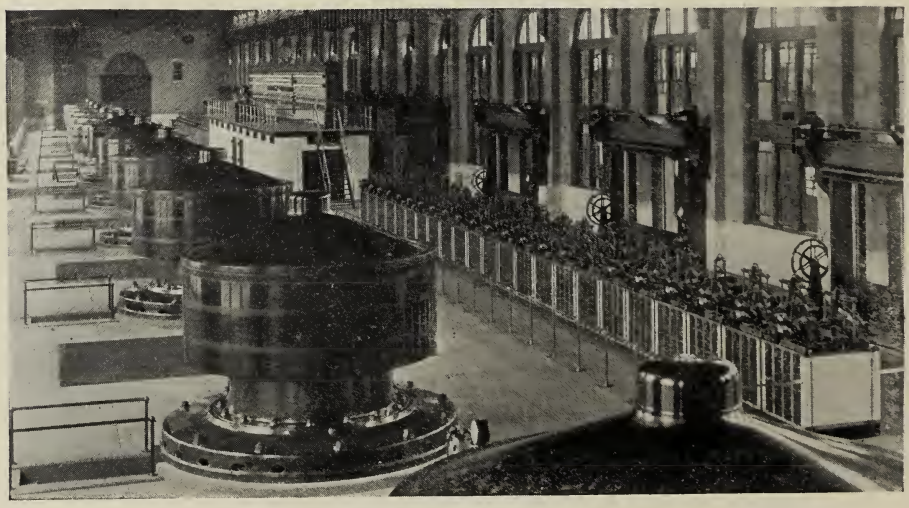
NIAGARA · FALLS · NEW · YORK · SYSTEM

THE NIAGARA FALLS POWER COMPANY

NUMBER OF GENERATING STATIONS: 3 · COMBINED CAPACITY: 157,000 K.W.

OUTPUT (YEAR, 1916): 1,015,400,000-K.W.-HR.

POWER HOUSE NO. 2 OF NIAGARA FALLS POWER CO.



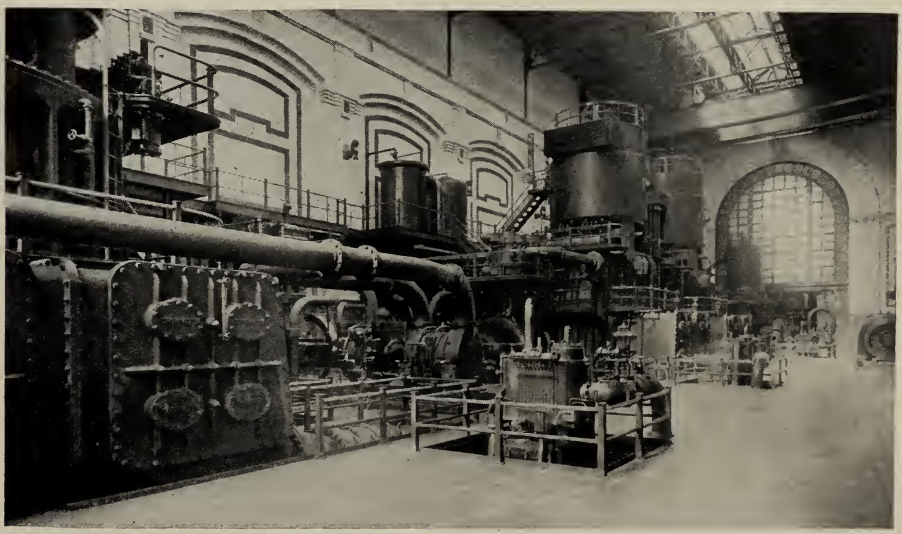
INTERIOR OF THE ABOVE

BOSTON · MASSACHUSETTS · SYSTEM

THE EDISON ELECTRIC ILLUMINATING CO. OF BOSTON

NUMBER OF GENERATING STATIONS: 3 · COMBINED CAPACITY: 115,400-K.-W.
OUTPUT (YEAR 1916): 237,500,000-K.-W.-HR.

"L" STREET STATION FROM THE WATER FRONT



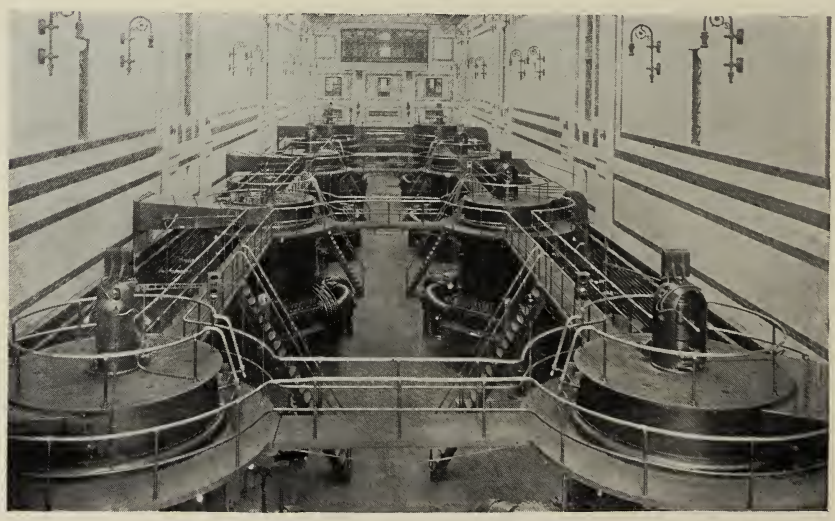
ONE OF THE TURBINE ROOMS IN THE "L" STREET STATION

NEW YORK CITY SYSTEM

THE NEW YORK EDISON COMPANY

NUMBER OF GENERATING STATIONS: 2 · COMBINED CAPACITY: 286,500 K.W.
OUTPUT FOR YEAR 1916 (INCLUDING U. E. L. & P. CO.): 856,400,000 K.W.-HR.

WATERSIDE STATION NO. 2



TURBINE ROOM OF STATION NO. 2

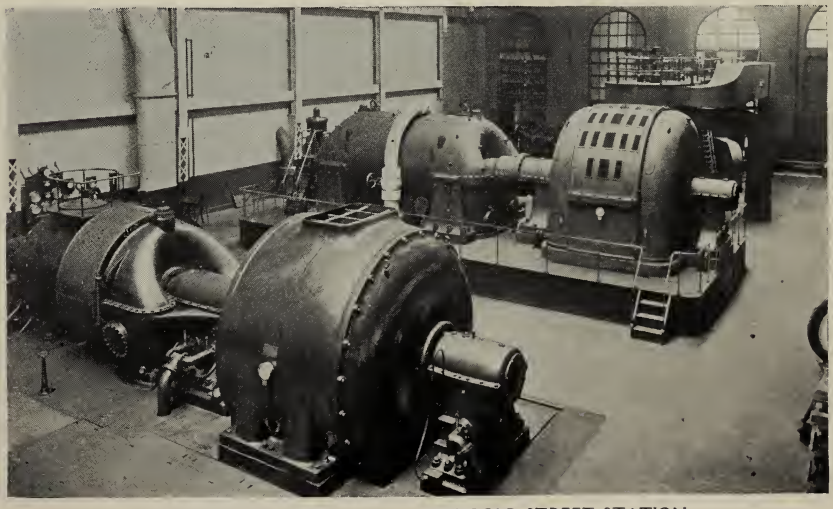
BROOKLYN · NEW YORK · SYSTEM

THE EDISON ELECTRIC ILLUMINATING COMPANY, OF BROOKLYN

NUMBER OF GENERATING STATIONS: 2 · COMBINED CAPACITY: 81,250 K.W.

OUTPUT (YEAR, 1916): 233,500,000-K. W.-HR.

GOLD STREET STATION



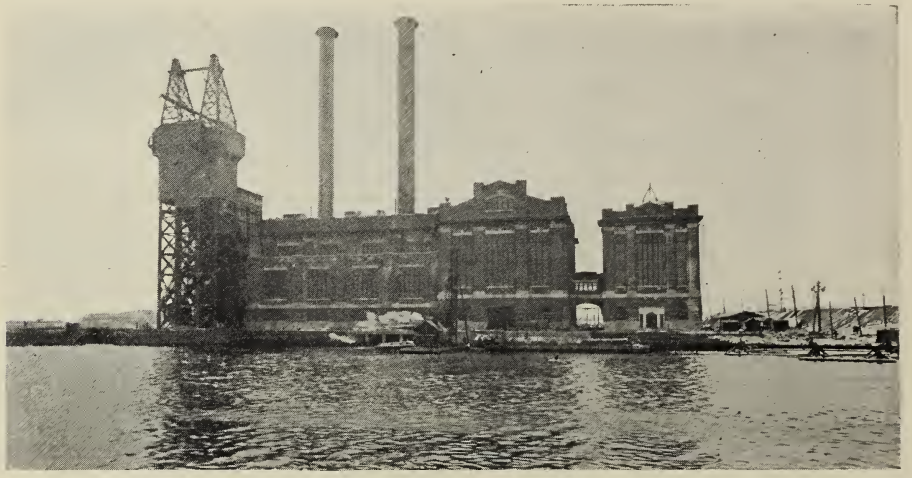
THE OPERATING FLOOR OF THE GOLD STREET STATION

NEWARK · NEW JERSEY · SYSTEM

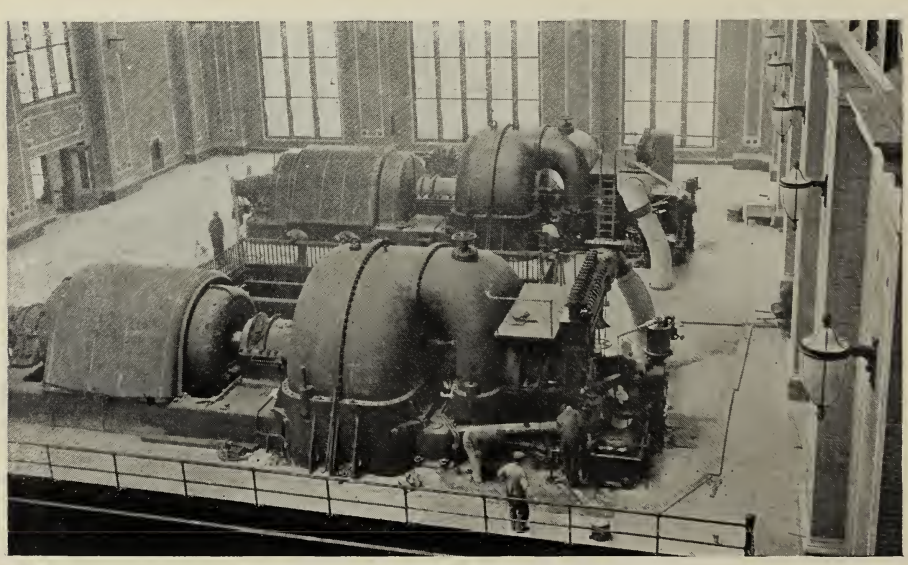
PUBLIC SERVICE ELECTRIC COMPANY

NUMBER OF GENERATING STATIONS: 20 · COMBINED CAPACITY: 224,500 K.W.

OUTPUT (YEAR: 1916): 607,000,000-K.W.-HR.



THE ESSEX POWER STATION



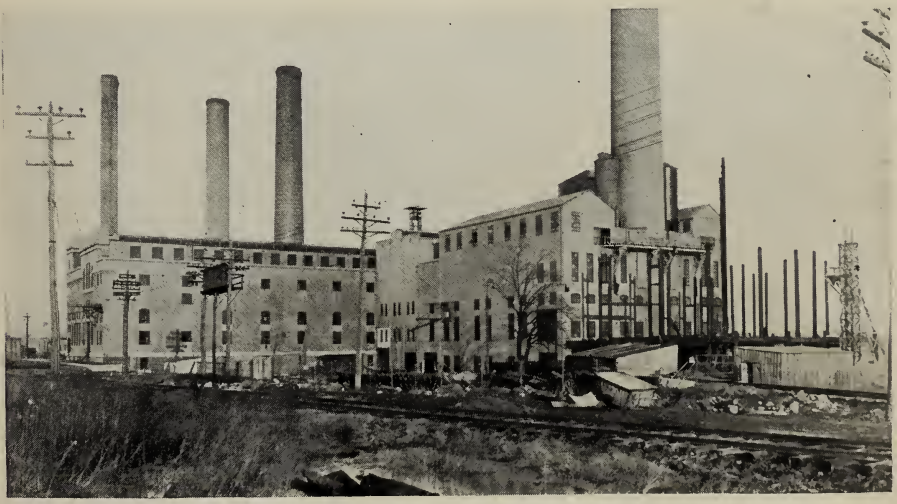
TURBO-GENERATORS IN THE ESSEX STATION

BALTIMORE · MARYLAND · SYSTEM

THE CONSOLIDATED GAS, ELECTRIC LIGHT
AND POWER COMPANY OF BALTIMORE

NUMBER OF GENERATING STATIONS: 2 · COMBINED CAPACITY 66,000 K.W.
OUTPUT (YEAR 1916): 249,800,000 K. W. HR.

McCALL'S FERRY POWER HOUSE AND DAM



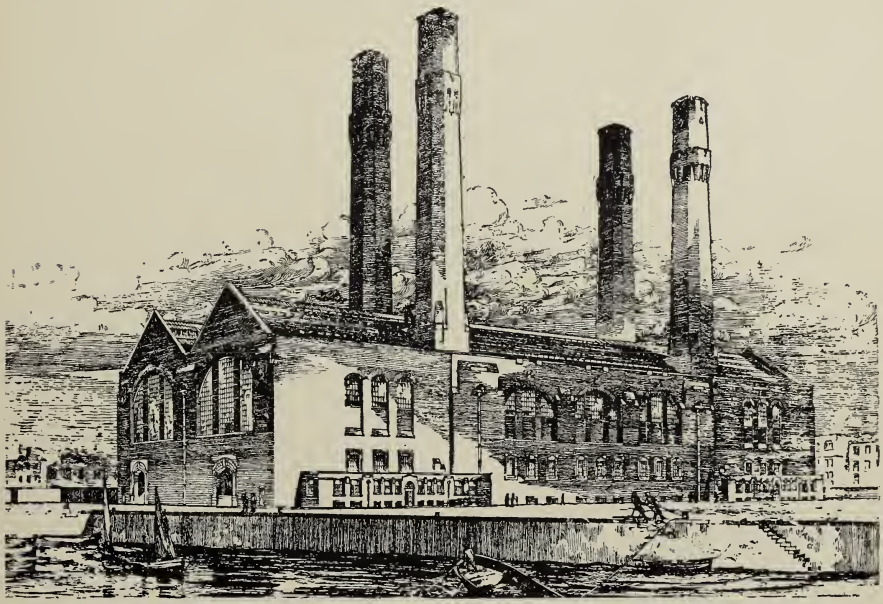
THE WESTPORT POWER HOUSE

NORTH · CAROLINA · SYSTEM
THE · SOUTHERN · POWER · COMPANY
NUMBER OF GENERATING STATIONS: 10 · COMBINED CAPACITY: 160,000 K.W.

NINETY-NINE ISLANDS POWER STATION

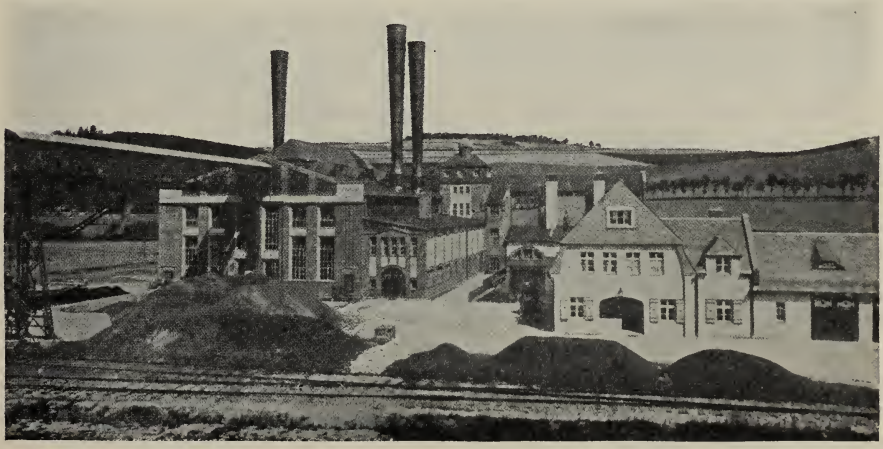
GREAT FALLS POWER STATION

CONTRAST THE ARCHITECTURAL FEATURES OF THE FOREGOING AMERICAN POWER STATIONS WITH THESE CONTINENTAL PLANTS:



POWER PLANT AT GREENWICH (ENGLAND) WHEN COMPLETE, BUT NOT SHOWING PIER AND COAL HANDLING PLANT

—Reproduced from "STEAM-ELECTRIC POWER PLANTS" by FRANK KOESTER, 1910



ARCHITECTURAL EXAMPLE—OBERERZGEBIRG, ELECTRICITY WORKS
Architect, DR. W. KLINGENBERG, BERLIN

—Reproduced from "LARGE ELECTRIC POWER STATIONS" by DR. G. S. KLINGENBERG, 1916

THE POWER COMPANY'S PROBLEMS AND FUTURE

The Opportunity for Technically-trained Men in the Industry

SECTION V:

OF the many problems which confront the modern Power Company, the two, which are perhaps of the most vital importance, are those of *economy* and *reliability*. Each of these problems is important not only to the company itself but to its customers. Both are so broad that they may be attacked from many different angles and points of vantage.

Consider *economy* for a moment and what it really means to the *Power Company!* We can immediately subdivide economy into two broad branches: economy of plant and economy of personnel. Plant here is used in the general sense, *i. e.*, to include *all company property* from the coal pile straight through to the customer's premises. The maintenance of all this tremendous variety and quantity of apparatus in the most efficient operating condition is a work of no mean proportions. The various ways and means in which operation can be improved in this great system are, of course, endless, and much too detailed to be considered here. I merely wish to point out as an example that large economies have been effected by properly proportioning each distributing transformer to its load. If a large economy can be attained thus, imagine how such factors as firing of boilers, proportioning of load to generators and innumerable other factors will affect the economy.

The second phase of economy is that of the personnel. The personnel consists broadly of two parts: executives and employees. Upon the extent to which all the personnel co-operates depends the economy of the system as a whole. The skillful management of the Power Company and its various departments has really as much to do with the economy of its production as the water rates of its turbines or the price it pays for coal. The efficiency with which the employees work depends, of course, upon the executives, and it is fully as important to economy as the work of the executives. The manner in which each employee carries out his daily task, however large or small, has a direct bearing upon the economy of the company. A good *esprit de corps* is as much to be prized as an efficient generating station. True, it must be admitted that the latter often makes the former more easily obtainable.

The question of *reliability* in the Power Company's work is essential; the watchword of the Power Companies is "continuity of service." This problem can be considered in much the same way as that of economy, namely, from the side of equipment and from the human side, both of which are essential and dependent upon each other. The equipment side may be helped in

numerous ways, such as reserve apparatus, duplicate auxiliaries and buses, protective devices, etc.; while the human side can be developed by the careful training of the men employed.

Another of the great problems which the Power Company has to meet is that of properly providing for its continued growth and expansion. This problem involves increasing all parts of the plant, generating station, distributing lines and sub-stations, at the same time maintaining reliability of service and economy of operation.

Exactly what the future holds for the power company from the technical standpoint is extremely chimerical and uncertain. From the great development through which the Industry has passed in the last few decades, it is reasonable to prophesy that still greater strides will be made in the development of prime movers, in the transmission of energy over long distances and in the still greater application of electrical energy to the many industrial activities of the country at large.

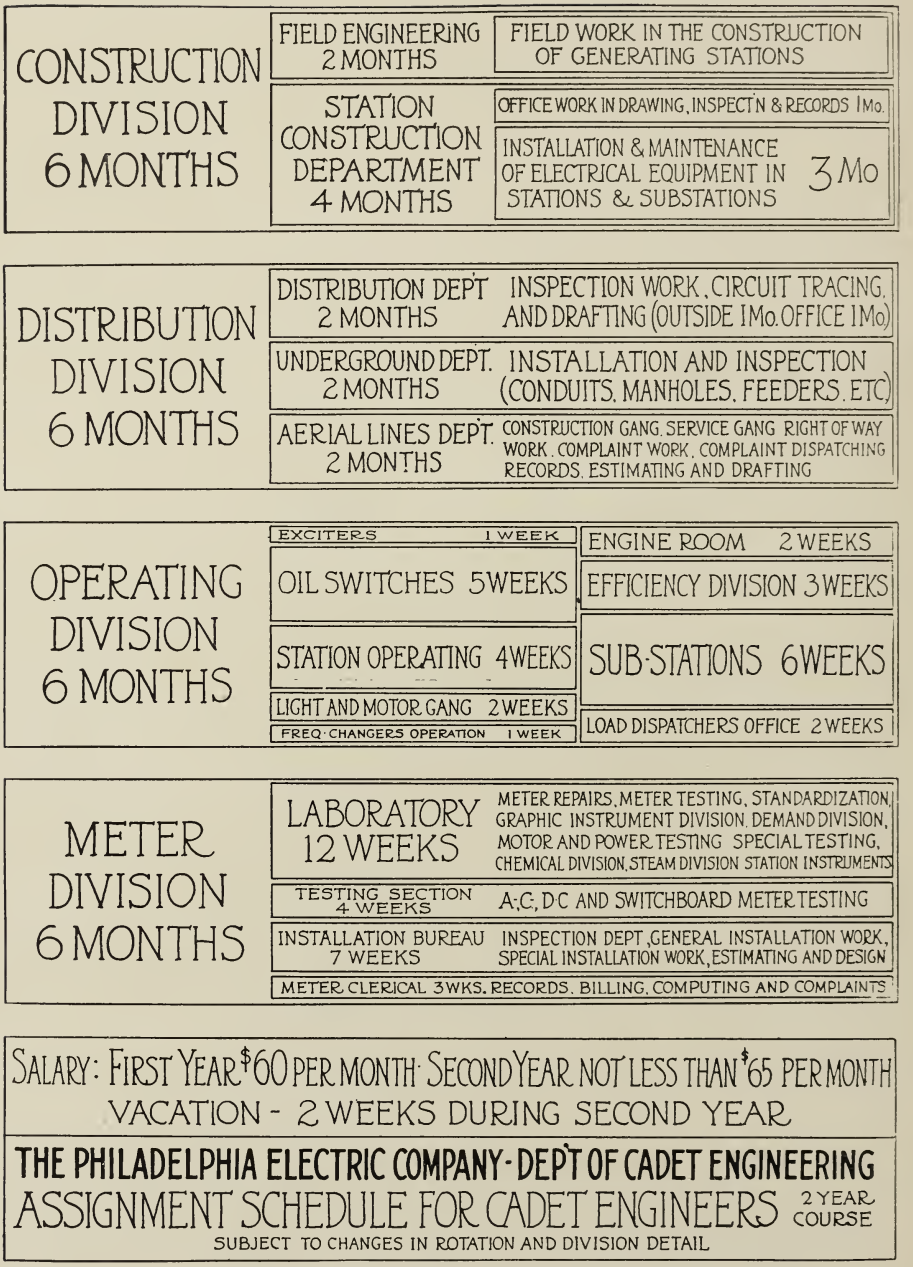
From economic considerations it is easy to foresee the Electrical Industry as widely developing in the future. The extension and interlacing of vast networks of copper for the distribution of electrical energy has already gone so far that shortly we may expect them to cover the surface of the country as completely as do the railroads, railways and roads. There is also little doubt but that electricity will become more and more of a household servant than it is at present. The field of application to transportation problems is practically unlimited, and it is extremely hard to predict what vast changes a few years may bring forth. Transportation, of course, includes railways and automobiles, in which latter field the electric truck has made such strides.

Innumerable examples could be cited, but the few cases which I have mentioned will serve to give some indication of what tremendous fields are opening up every year to the Electrical Power Company.

The curve on page 91 shows what the growth has been in Philadelphia, and is typical of the general trend of the industry throughout the country. It is interesting to note that even when the country was under the stressed financial conditions of 1907, the curve did not fall back, but has continuously had an upward trend. It is chiefly upon this curve that I base my assertion that the college man has unparalleled opportunities in the Power Company today. The reason is self-evident.

Realizing that the power company needs men of the highest type and education, for the successful achievement of its problems and accomplishment of its work, several of the leading companies have organized what are termed *cadet engineering courses.* The object of these is to familiarize the technical graduate with plant property and the methods of the large com-

Continued on page 92


CONSTRUCTION DIVISION 6 MONTHS
FIELD ENGINEERING 2 MONTHS
FIELD WORK IN THE CONSTRUCTION OF GENERATING STATIONS
STATION CONSTRUCTION DEPARTMENT 4 MONTHS
OFFICE WORK IN DRAWING, INSPECT'N & RECORDS 1 Mo.
INSTALLATION & MAINTENANCE OF ELECTRICAL EQUIPMENT IN STATIONS & SUBSTATIONS 3 Mo
DISTRIBUTION DIVISION 6 MONTHS
DISTRIBUTION DEPT 2 MONTHS
INSPECTION WORK, CIRCUIT TRACING, AND DRAFTING (OUTSIDE 1 Mo. OFFICE 1 Mo)
UNDERGROUND DEPT. 2 MONTHS
INSTALLATION AND INSPECTION (CONDUITS, MANHOLES, FEEDERS, ETC)
AERIAL LINES DEPT. 2 MONTHS
CONSTRUCTION GANG, SERVICE GANG, RIGHT OF WAY WORK, COMPLAINT WORK, COMPLAINT DISPATCHING RECORDS, ESTIMATING AND DRAFTING
OPERATING DIVISION 6 MONTHS
EXCITERS 1 WEEK
OIL SWITCHES 5 WEEKS
STATION OPERATING 4 WEEKS
LIGHT AND MOTOR GANG 2 WEEKS
FREQ. CHANGERS OPERATION 1 WEEK
ENGINE ROOM 2 WEEKS
EFFICIENCY DIVISION 3 WEEKS
SUB-STATIONS 6 WEEKS
LOAD DISPATCHERS OFFICE 2 WEEKS
METER DIVISION 6 MONTHS
LABORATORY 12 WEEKS
METER REPAIRS, METER TESTING, STANDARDIZATION, GRAPHIC INSTRUMENT DIVISION, DEMAND DIVISION, MOTOR AND POWER TESTING SPECIAL TESTING, CHEMICAL DIVISION, STEAM DIVISION STATION INSTRUMENTS
TESTING SECTION 4 WEEKS
A.C., D.C AND SWITCHBOARD METER TESTING
INSTALLATION BUREAU 7 WEEKS
INSPECTION DEPT, GENERAL INSTALLATION WORK, SPECIAL INSTALLATION WORK, ESTIMATING AND DESIGN
METER CLERICAL 3 WKS. RECORDS, BILLING, COMPUTING AND COMPLAINTS
SALARY: FIRST YEAR $60 PER MONTH: SECOND YEAR NOT LESS THAN $65 PER MONTH
VACATION - 2 WEEKS DURING SECOND YEAR
THE PHILADELPHIA ELECTRIC COMPANY - DEPT OF CADET ENGINEERING
ASSIGNMENT SCHEDULE FOR CADET ENGINEERS 2 YEAR COURSE
SUBJECT TO CHANGES IN ROTATION AND DIVISION DETAIL

F. 1095 750 2 1917

THE PHILADELPHIA ELECTRIC COMPANY App. No. 281

APPLICATION FOR DEPT. OF CADET ENGINEERING

I hereby apply for enrollment in the Dept. of Cadet Engineering of The Philadelphia Electric Company

Date April 25th 1917 (Signed) Joseph Doe, Jr.

Local Address: 63 '79 Hall, Princeton, N.J.

Permanent Mailing Address: R.F. #3, Pokeville, Ill.

College: Prin. Univ. Class and Course: E.E. 1917 Degrees held: BS '15, EE '17

Do you enroll for the summer or two year course? For 2 Year Course

Accepted B Frank Day Director | Reporting Date: 7-1-17

~~Rejected~~ Date 4/28/1917 | To Oper. Dept.

(Enter further comments on back)

F. 1096 750 2 1917

Application No. 281

THE PHILADELPHIA ELECTRIC COMPANY, 1000 CHESTNUT STREET, PHILADELPHIA

DEPARTMENT OF CADET ENGINEERING

PRELIMINARY RECORD OF APPLICANT

(A small inexpensive photograph of applicant should accompany application, if possible)

Name Joseph Doe, Jr. Date April 25th 1917

Permanent mailing address R.F. #3, Pokeville, Illinois

Local address 63 '79 Hall, Princeton University, Princeton, N.J.

Date of birth June 4th 1894 Height 6 ft. 0½ in. Weight 196 lb. Nationality American

Married or single Single Father's business Textile Manufacturer

PREP. SCHOOLS AND COLLEGES ATTENDED	COURSE	No. YEARS	YEAR GRADUATED	DEGREES
Pokeville (Ill.) High School	High School Course	3 yr.	1910	—
Lawrenceville School	College Prep.	1 yr.	1911	—
Princeton University	B.S.	4 yr.	1915	B.S.
do.	E.E.	2 yr	1917	E.E.

What part was taken in student activities? Varsity Football Team, Swimming Team, Editor "Princetonian"

Do you know of any reason why you could not pass a physical examination? No

PREVIOUS EXPERIENCE, INCLUDING REMUNERATIVE WORK DURING VACATIONS AND COLLEGE PERIOD

KIND OF WORK	NAME OF EMPLOYER	ADDRESS	HOW LONG EMPLOYED
Textile Manufacturing	Doe & Roe Mfg. Co.	Pokeville P.O. Ill.	2 Summers
Power House Work	Pokeville El. Light & Pr. Co.	do.	1 Summer
Car Inspector	Pokeville Urban Railways	Poke County, Ill.	1 Summer
Executive Offices	do.	do	1 Summer

Per cent. college expenses earned 15 per cent (Approx.)

What branch of engineering do you expect to follow? Electrical Engineering

ITEMS BELOW NOT TO BE FILLED IN BY APPLICANT

Professor's Comment PROFESSOR A. advises this man is thoroughly grounded, has shown especial application in his studies and an unusual degree of independence. Has high recommendation from the engineering faculty.

Striking Characteristics Favorable first impression. Good on a-c. theory. Some practical experience (see above).

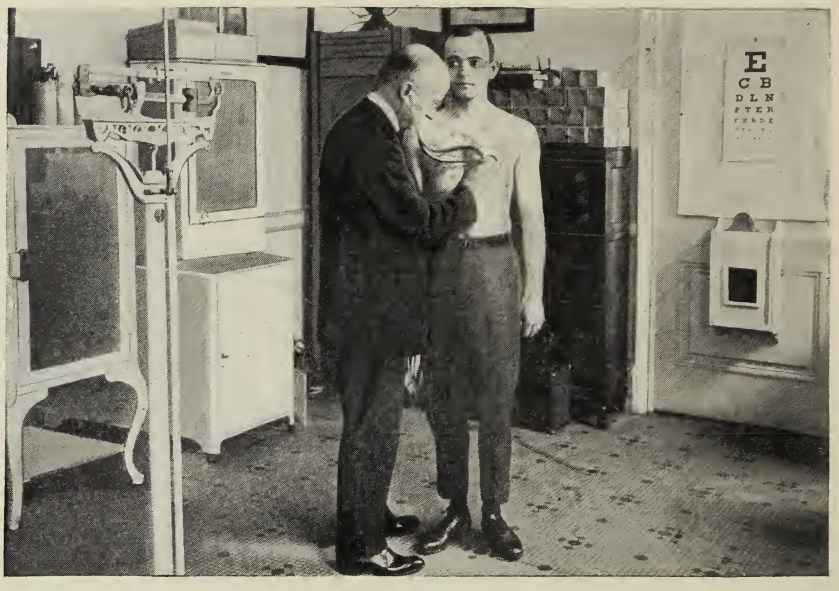
Impressions

Appearance ok	Clearness ok	Decision ok	Personality ok
Refinement	Quickness ok	Expressiveness – ?	Tact – ?
Maturity ok	Breadth – ?	Enthusiasm ok	Health Unusual!

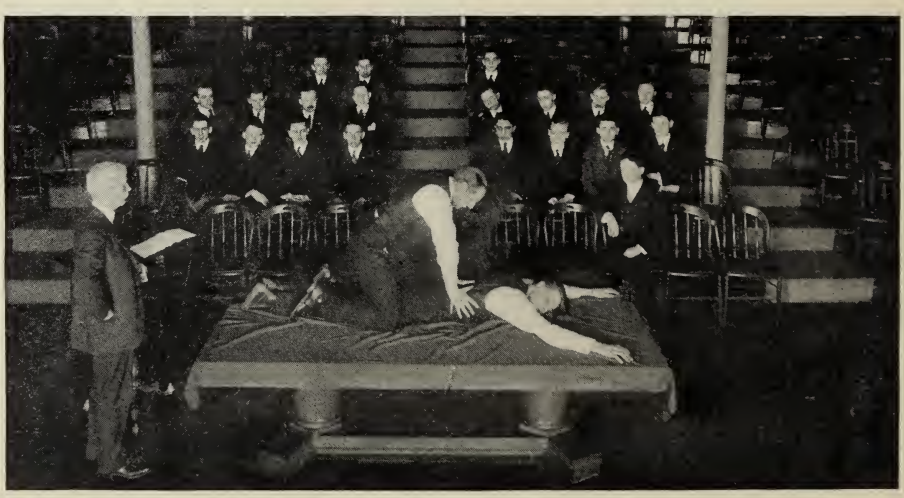
Interviewed by J. Benj. Dam, Dept. Cadet Eng. Date 4/25/17

APPLICATION FORMS FOR DEPARTMENT OF CADET ENGINEERING

"JOSEPH DOE, Jr.," HAVING FILLED OUT THE ABOVE FORMS, IS INTERVIEWED BY COMPANY REPRESENTATIVE AT HIS COLLEGE, AND LATER ADVISED OF THE ACTION TAKEN ON HIS APPLICATION

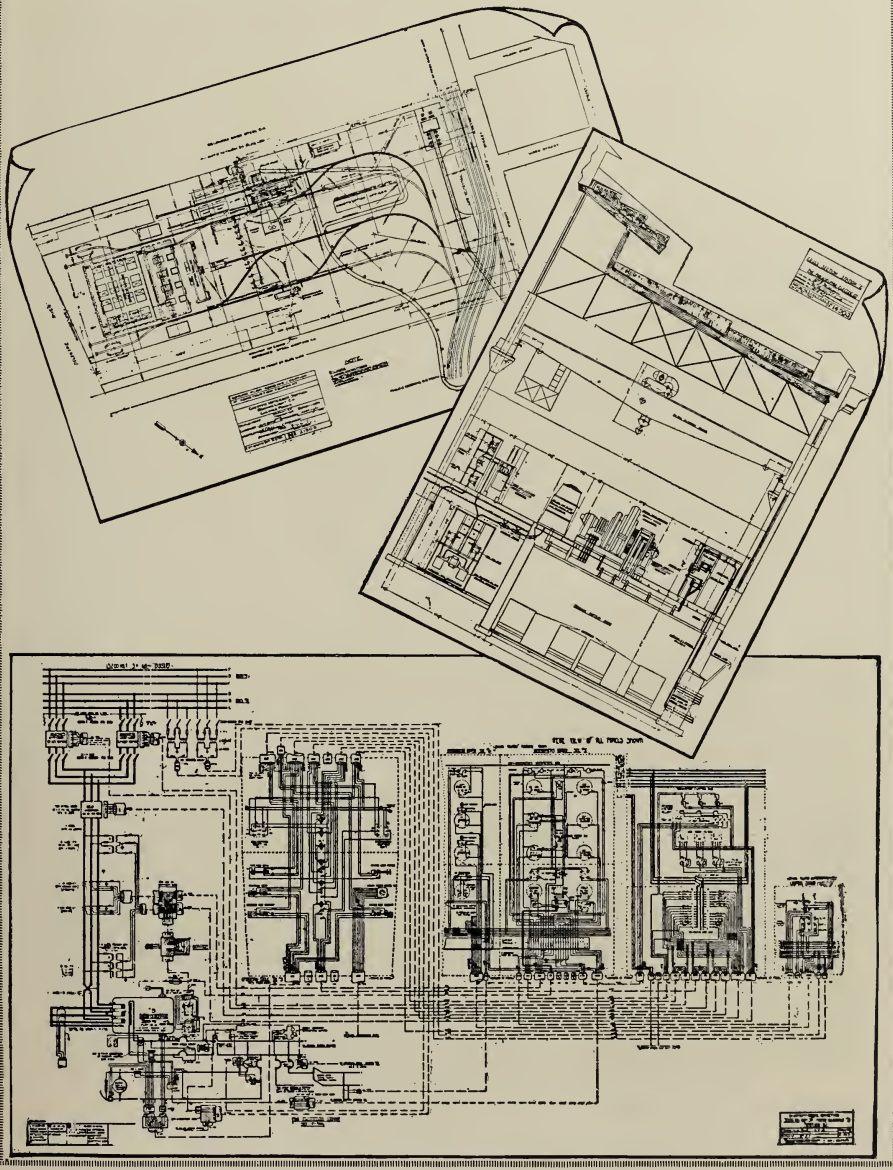


"JOSEPH DOE, Jr.", WHEN EMPLOYED, IS EXAMINED BY THE COMPANY'S PHYSICIAN



"JOSEPH DOE, Jr.", WITH FELLOW CADET ENGINEERS, RECEIVING INSTRUCTION IN A "RESUSCITATION FROM ELECTRIC SHOCK" DRILL. PRONE-PRESSURE METHOD USED

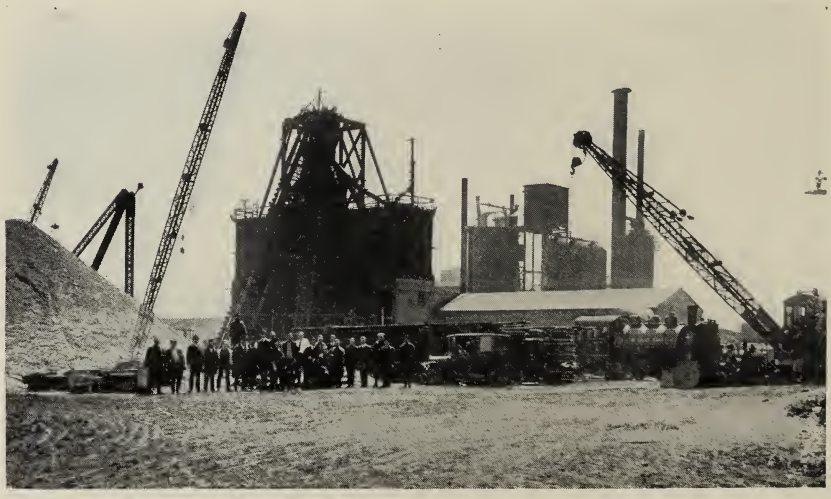
THE SCOPE OF THE ENGINEERING DEPARTMENTS OF THE POWER COMPANIES EMBRACE ELECTRICAL, MECHANICAL AND CIVIL ENGINEERING



"JOSEPH DOE, Jr." HAS OPPORTUNITIES AS A CADET ENGINEER, ALIKE:

IN THE DESIGN ROOM—

ONE OF THE PHILADELPHIA ELECTRIC COMPANY'S DRAUGHTING ROOMS



AND, IN THE FIELD

FIELD ENGINEER'S STAFF FOR CONSTRUCTION OF CHESTER WATERSIDE STATION

HIS ATHLETIC ABILITIES ARE GIVEN OPPORTUNITY FOR EXERCISE AT THE COMPANY'S ATHLETIC GROUNDS, SITUATED IN THE COUNTRY OUTSIDE OF PHILADELPHIA. BASEBALL, TENNIS, GOLF, SOCCER AND TRAP-SHOOTING

From a Recent Issue

CURRENT NEWS *for*

DEPARTMENT OF CADET ENGINEERING

THE arrival of Spring has been welcomed by those cadet engineers having assignments in the departments involving outdoor work. Their lot is justly envied by our staff with its editorial responsibilities.

Last year eleven different colleges were represented by the cadet engineers enrolled and this year that number will be considerably enlarged. The Philadelphia Electric Company is in an especially attractive position to offer a broad training in Operating Company work to graduate and undergraduate engineers. The present and prospective plans for increasing station capacity, the erection of high tension lines and the increased activities of all divisions of the Engineering Department indicate a variety of opportunities for cadet engineers to acquire a special training. The future demands of this expansion for trained engineers who have demonstrated their ability to assume responsibilities is too obvious to require elaboration. All of us may not achieve the limit of our ambitions, but a personal inventory may largely explain any marked sluggishness in our advancement.

"When training in *practical work* supplements technical education, Success has a slim chance of getting away!"

B. Frank Bay *Director*

PERSONALS

The ranks of the cadet engineers were increased in March by the transfer of Norman F. Rigor of the Testing Section and Peter A. Cautilli of the Distribution Department to the Department of Cadet Engineering. These two men are the first employees to take advantage of the opportunity afforded present employees who are not university graduates to enroll as cadet engineers. They successfully passed the requirements of the Examining Committee and their very creditable records as employees should make their future success assured.

O. Denny Brereton has been enrolled as a two-year cadet after recently graduating from Princeton University in Civil Engineering. He spent last summer in the Field Engineering Department and his first assignment is the Aerial Department under the able supervision of Mr. J. C. Cross.

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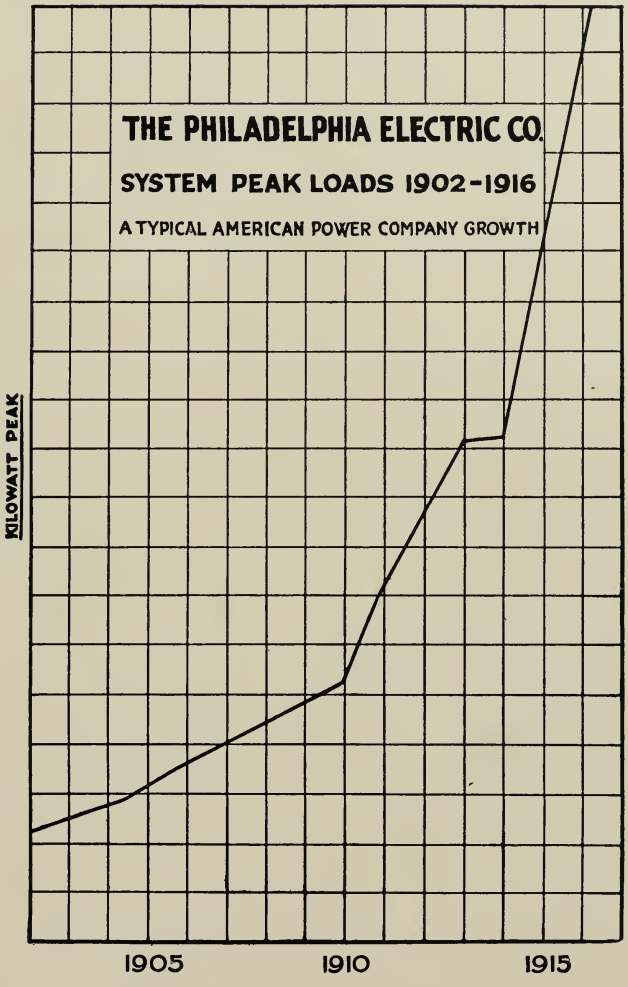


"A CONTINUOUS UPWARD SLOPE SHOWS THE UNLIMITED OPPORTUNITIES IN THE INDUSTRY"

THIS IS A MATTER FOR CONSIDERATION BY THE COLLEGE MAN!

pany; also to enable him to obtain a birds-eye view of the company as a whole without losing himself in the maze of necessary but involved detail.

The courses aim to put the cadet consecutively in the plants and out with the service gangs, etc., for a period of usually two years. In this way there is obtained an intimate and first-hand knowledge of the work, the fellow-employee and his attitude of mind. The personal knowledge thus gained of the men and their problems is of intense value later on, when the cadet may be called upon to direct their efforts. The courses for cadet engineers may be readily likened to the hospital training of a young physician, immediately after he has taken his college degree.

As a reminder, I wish again to call your attention to the curve on page 11 which shows the past growth of the industry. It predicts to even the most unimaginative mind a brilliant future.

A far-reaching influence in the choice of his life work should be the Opportunities held out today by the Power Companies to the university-trained man!

THE HUMAN SIDE OF THE POWER COMPANY ORGANIZATION

SECTION VI:

BEFORE going on with the organization of the Power Company, let us consider for a moment some of the special conditions which it must face and meet successfully. Primarily, sight must not be lost of the fact that the supply of electricity is a public service and must go on continuously despite any unfavorable external conditions which may obtain. In other words, *service* must be always uppermost in the mind of the employee of the Power Company. The company property is valuable and must be handled by responsible and trained men; men who are consistently muddle-headed or forgetful cannot be tolerated.

A certain unique condition which holds for the production of electrical energy, which means a good deal to operation, is the fact that the energy must be generated at *exactly* the same rate at which it is required, or to put it differently, it is not possible to manufacture and store up economically electrical energy ahead of time to await an anticipated demand. This condition, although axiomatic of the most fundamental elements of the science, is often lost sight of, but is particularly significant inasmuch as it implies that all equipment should be maintained in first-class operating condition ready for instant use.

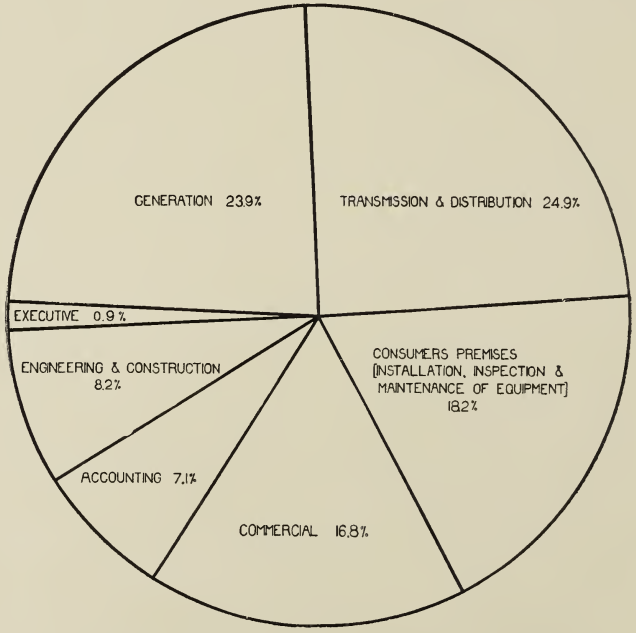
The conditions which I have outlined will show you that the Power Company must meet particularly hard requirements, especially with regard to *service*. The organization to do this must be a *co-operative* body of trained employees, each one of whom is especially responsible for the successful execution of his own work. A glance at page 94 will show you a typical Power Company organization, and lead to a realization of the diversified force necessary to prosecute the work in hand. The illustrations on pages 95 to 100 show in greater detail the work of some of the power company departments.

The attention which is given to the general advancement and well-being of its men by the Power Company is a necessary adjunct to its most efficient organization. The company considers it part of its duty toward its men to look after their mental and physical welfare. In this branch of enlightened activity, the Power Company has been a pioneer, for the responsible and complicated nature of its work has made it quick to realize that making a happy employee is the greatest step it can take toward promoting general co-operation and efficiency within itself.

Perhaps the greatest single step which has been taken for the welfare of the employee is the establishment of what is often known as a beneficial

Continued on page 110

THE MAKE-UP OF A POWER COMPANY ORGANIZATION



DISTRIBUTION OF EMPLOYMENT THE PHILADELPHIA ELECTRIC CO.

JANUARY, 1, 1917

Department	No. Employees	Percentage
Executive	30	0.9
Engineering and Construction	276	8.2
Generation	803	23.9
Transmission and Distribution	831	24.9
Customers Premises (See Chart)	614	18.2
Commercial	569	16.8
Accounting	240	7.1
Total Number Employees	3363	100.0

"SAFETY FIRST" IN THE POWER COMPANIES

ACCIDENT PREVENTION WORK IS CARRIED ON THROUGHOUT THE INDUSTRY

TYPICAL "BULLETIN"

SAFETY BULLETIN BOARDS

THROUGH CO-OPERATION WITH THE NATIONAL SAFETY ORGANIZATION, THE NATIONAL SAFETY COUNCIL, OF CHICAGO, AND WITH THE N. E. L. A. BUREAU OF SAFETY, BULLETINS AND DATA ARE AVAILABLE, AND ORGANIZED ACCIDENT PREVENTION WORK IS MADE A PART OF POWER COMPANY ADMINISTRATION

IN THE POWER COMPANY, THE COMMERCIAL AND

TYPICAL STREET CAR
POSTERS

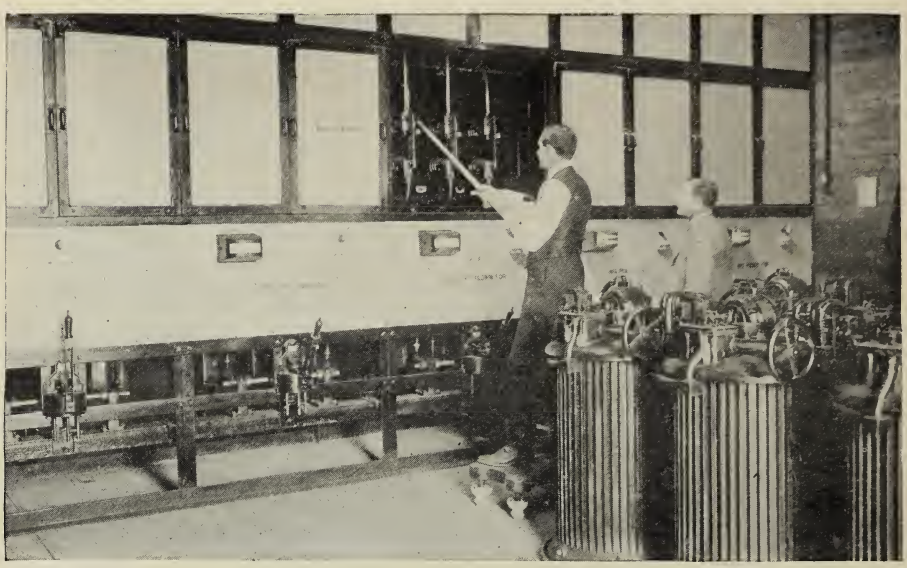
THE MANY OTHER FORMS OF PUBLICITY, EMPLOYED, INCLUDE POSTERS ON COMPANY TRUCKS AND ON BILLBOARDS, NEWSPAPER, LOCAL MAGAZINES AND THEATRE PRO-

PUBLICITY DEPARTMENTS WORK HAND-IN-HAND

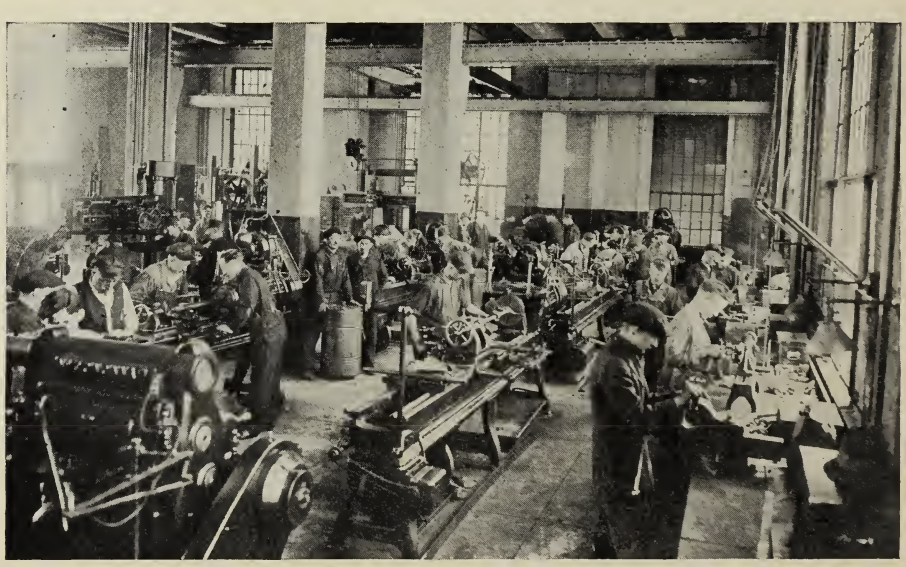
COMPANY "BULLETINS" SENT OUT PERIODICALLY TO CUSTOMERS

GRAM ADVERTISING, FOLDERS ENCLOSED IN BILLS TO CUSTOMERS, ELECTRIC SIGN DISPLAY, ATTRACTIVE "ELECTRIC SHOPS", COMMERCIAL DISTRICT OFFICES, ETC.

DIVERSITY OF DEPARTMENTAL ACTIVITY IN THE POWER COMPANY



INSPECTION OF AN INDUSTRIAL SUB-STATION



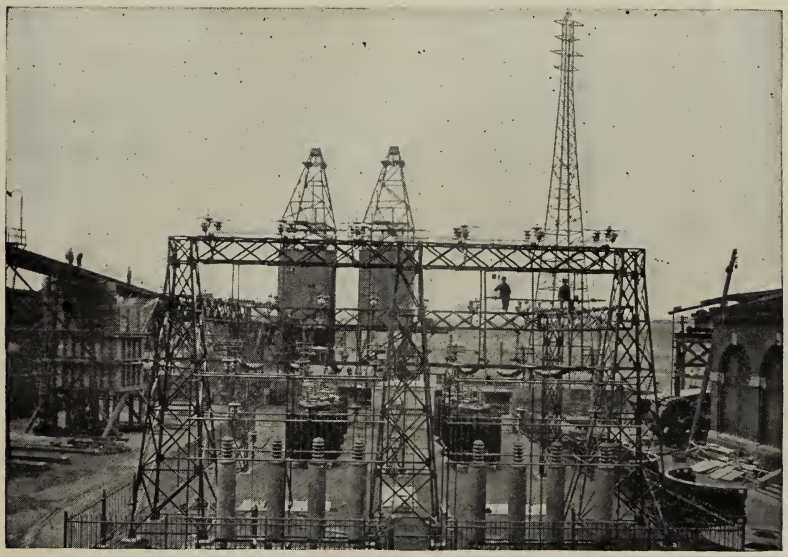
MACHINE SHOP FOR PLANT MAINTENANCE

OPERATING DIVISION

DIVERSITY OF DEPARTMENTAL ACTIVITY IN THE POWER COMPANY

TRUCK "HAULING-IN" UNDERGROUND CABLE

DISTRIBUTION DIVISION

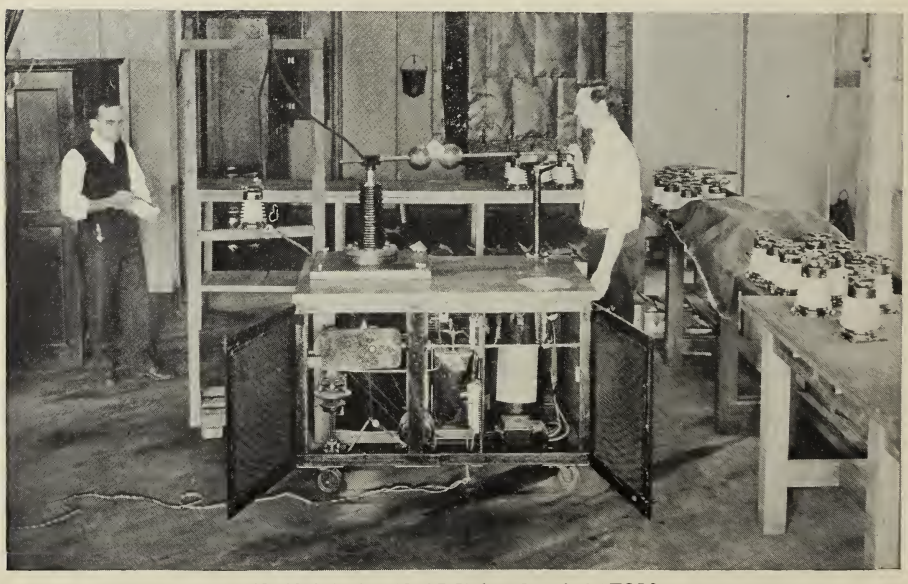


PAINTING AN OUTDOOR SUB-STATION

CONSTRUCTION DIVISION

DIVERSITY OF DEPARTMENTAL ACTIVITY IN THE POWER COMPANY

ROUTINE METER TESTING



SPECIAL TESTING OF BUS BAR INSULATORS

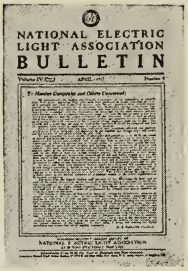
METER DIVISION

In the Power Company field, undoubtedly the greatest factor in the development of the industry as a whole, is the National Electric Light Association, established in 1885, and today one of the oldest, largest, livest engineering societies in America!

THE ANNUAL CONVENTIONS, SINCE 1885, HAVE BEEN THE BIGGEST YEARLY EVENT IN THE INDUSTRY. GROUP OF DELEGATES AT SAN FRANCISCO CONVENTION—1915.

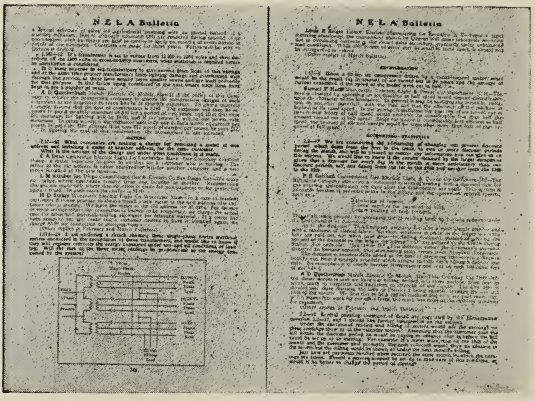
The National Electric Light Association was established February 25, 1885; has a present membership of over 15,000; has eleven Geographic Sections, and sixty-four member Company Sections. In the Association's organization are at work some seventy committees—standing and special—with upwards of 600 men, the pick of the industry, serving on these committees. Approximately 4000 members attended the 1916 Convention, held at Chicago, and the average attendance for all Conventions, 1885-1916, is nearly 3000, with a total of upwards of 29,000 delegates registered in the last ten years!

THE TECHNICAL LIT-
BY · THE · NATIONAL
ASSOCIATION · COM-
THOUGHT · OF · THE
IN · THE · WHOLE

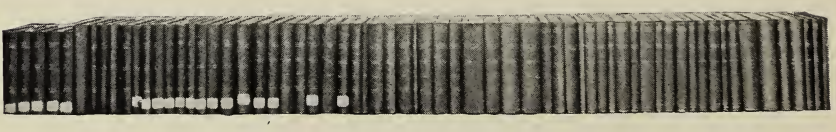


ERATURE SENT OUT
ELECTRIC · LIGHT
PRISES · THE · BEST
BRIGHTEST · MEN
OF · THE · INDUSTRY!

SINCE ITS FIRST ISSUE IN AUGUST,
1907, THE N. E. L. A. BULLETIN HAS
PRINTED · OVER · 6000 · PAGES



THE "QUESTION BOX", SINCE 1901, HAS CON-
TAINED 5,686 QUESTIONS AND 20,377 ANSWERS



RATHER LONGER THAN DR. ELIOT'S "5-FOOT SHELF"!
N. E. L. A. CONVENTION PROCEEDINGS: 1885-1916

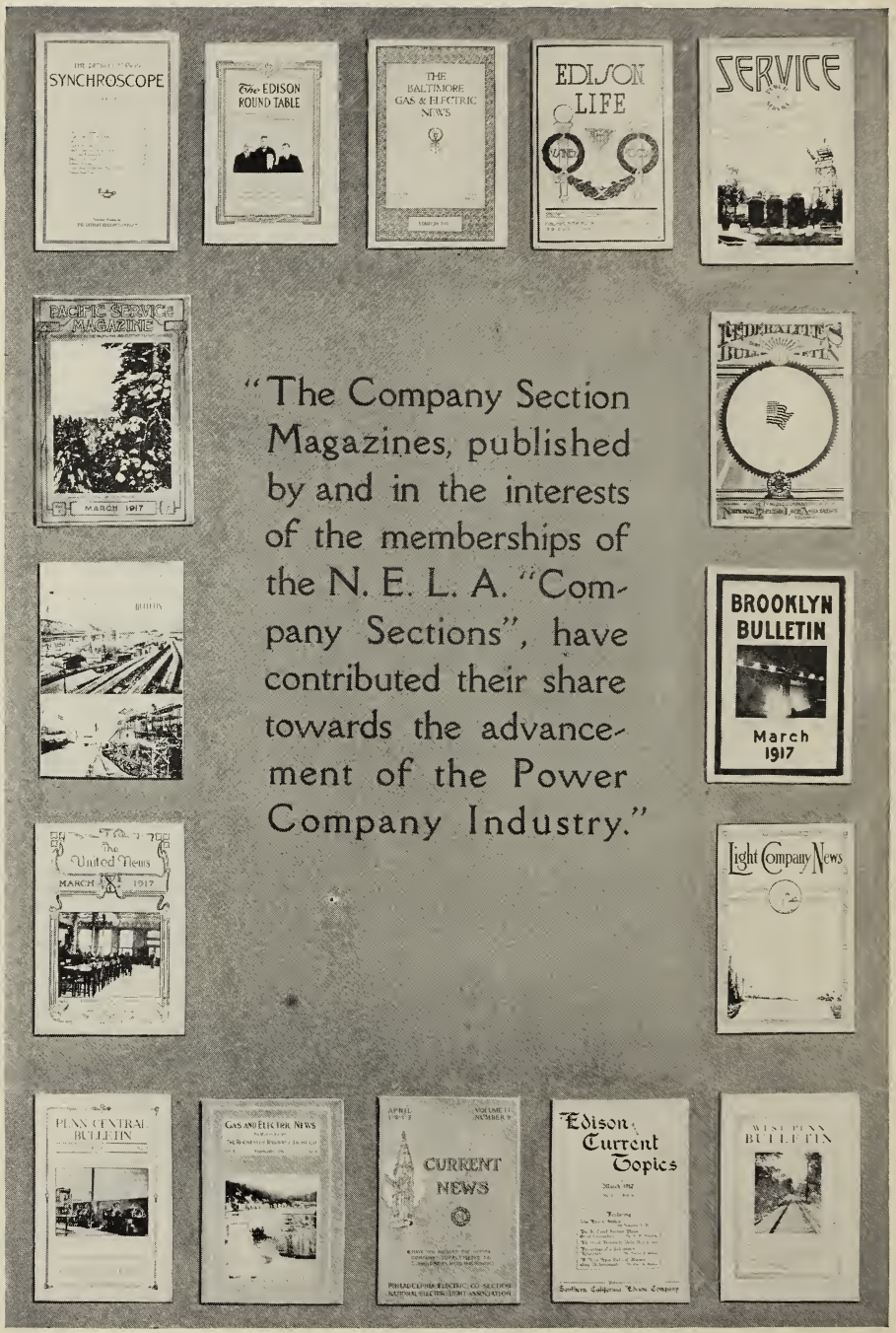
Over 800,000 pieces of printed matter were printed and distributed last year. This included copies of the "Bulletin," bound volumes of the "Proceedings," some half dozen publications of the Commercial Section, four Handbooks, the Resuscitation Chart and Booklet, etc., etc.

"FROM COAST TO COAST ARE FOUND THE ACTIVITIES OF THE GEOGRAPHICAL SECTIONS OF THE N. E. L. A."

A TYPICAL "SECTION CONVENTION" GROUP

DELEGATES AT A PENNSYLVANIA STATE ELECTRIC ASSOCIATION CONVENTION, AT BEDFORD SPRINGS, PENNSYLVANIA

THERE ARE ELEVEN GEOGRAPHICAL SECTIONS IN THE NATIONAL · ELECTRIC · LIGHT · ASSOCIATION



"The Company Section Magazines, published by and in the interests of the memberships of the N. E. L. A. "Company Sections", have contributed their share towards the advancement of the Power Company Industry."

for **APRIL, 1917**

THE NATIONAL ELECTRIC LIGHT ASSOCIATION "COMPANY SECTIONS" FORMED IN MANY OF THE LARGER MEMBER COMPANIES, RECEIVE ENTHUSIASTIC SUPPORT FROM THEIR MEMBERSHIPS:

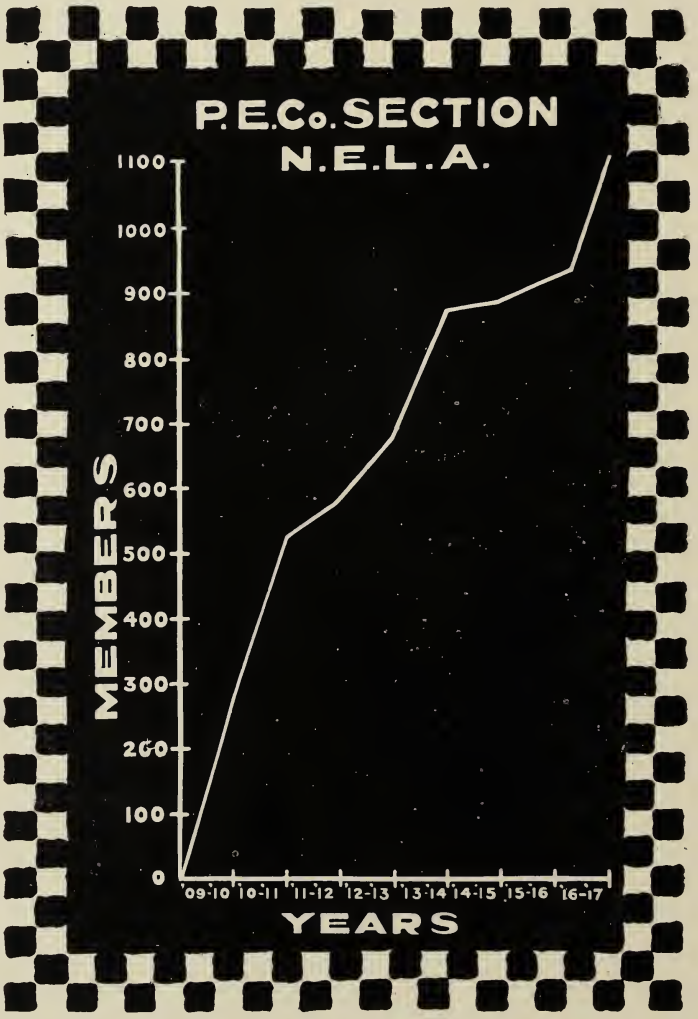
The N. E. L. A. COMPANY SECTIONS

From a Recent Country-Wide Canvass by Our Section Secretary

Organized		Present Membership
August 24, 1908	Commonwealth Edison Co., Chicago, Ill	1087
September 17, 1908	Public Service Co. of Northern Illinois, Chicago, Ill	230
October 2, 1908	Edison Electric Illuminating Co., Brooklyn, N. Y	1130
October 19, 1908	Edison Electric Illuminating Co., Boston, Mass	200
March 15, 1909	PHILADELPHIA ELECTRIC CO., PHILADELPHIA, PA	925
March 17, 1909	Public Service Electric Co., Newark, N. J	853
May 28, 1909	Consolidated Gas, Electric Lt. and Power Co., Baltimore, Md.	577
September 1, 1909	Rochester Railway and Light Co., Rochester, N. Y	40
September 1909	Toronto Electric Light Co. Ltd., Toronto, Ont	2
October 22, 1909	Buffalo Company Section, Buffalo, N. Y	218
1909	West Penn Electric Co., Connellsville, Pa	
1909	Denver Gas and Electric Light Co., Denver, Colo	
March 21, 1910	Union Electric Light and Power Co., St. Louis, Mo	
June 29, 1910	Syracuse Lighting Co., Syracuse, N. Y	175
November 1910	New York Companies' Section, New York	1568
February 2, 1911	Duquesne Light Co., Pittsburgh, Pa	991
April 11, 1911	Empire District Electric Co., Joplin, Mo	41
May 19, 1911	Milwaukee Electric Railway and Light Co., Milwaukee, Wis.	115
November 9, 1911	Ottawa Electric Co., Ottawa, Ont	14
December 11, 1911	Pacific Power and Light Co., Portland, Ore	85
1911	Penn Central Light and Power Co., Altoona, Pa	250
January 24, 1912	Hamilton Cataract Pwr., Lt. and Traction Co., Hamilton, Ont	14
August 9, 1912	Kansas City Light and Power Co., Kansas City, Mo	82
October 17, 1912	Pacific Gas and Electric Co., San Francisco, Cal	409
December 17, 1912	Illinois Northern Utilities Co., Dixon, Ill	25
March 10, 1913	Roanoke Railway and Electric Co., Roanoke, Va	39
May 2, 1913	Trinidad Electric Trans. Ry. and Gas Co., Trinidad, Colo	35
June 30, 1914	Lehigh Valley Light and Power Co., Allentown, Pa	50
December 15, 1914	Manila Electric R. R. and Light Co., Manila, P. I	
January 11, 1915	Rumford Falls Light and Water Co., Rumford, Me	24
January 21, 1915	Consolidated Gas Co. of New Jersey, Long Branch, N. J	7
January 28, 1915	Union Gas and Electric Co., Cincinnati, O	243
February 2, 1915	Mansfield Railway, Light and Power Co., Mansfield, O	12
February 3, 1915	Dayton Power and Light Co., Dayton, O	80
March 29, 1915	Blackstone Valley Gas and Electric Co., Woonsocket, R. I	16
June 25, 1915	California-Oregon Power Co., Medford, Ore	
June 28, 1915	Great Western Power Co., Sacramento, Cal	
September 1915	Erie Lighting Co., Erie, Pa	61
October 28, 1915	Middletown Gas and Electric Co., Middletown, O	20
October 28, 1915	Utah Power and Light Co., Salt Lake City, Utah	126
December 1, 1915	Penn Public Service Co., Clearfield, Pa	34
January 26, 1916	Central Power Co., Grand Island, Neb	45
February 24, 1916	Newport News and Hampton Railway, Gas and Electric Co., Newport News, Va	22
February 24, 1916	Plymouth Electric Light Co., Plymouth, Mass	15
March 13, 1916	Great Western Power Co., Oakland, Cal	45
March 14, 1916	Binghamton Light, Heat and Power Co., Binghamton, N. Y.	36
March 24, 1916	New Bedford Gas and Edison Light Co., New Bedford, Mass.	16
No returns received	Columbus R. R. Co., Columbus, Ga	
	St. Paul Gas Light Co., St. Paul, Minn	
	San Antonio Gas and Electric Co., San Antonio, Tex	
	British Columbia Electric Rwy. Co., Vancouver, B. C., Can	

A COMPILATION OF THE COMPANY SECTIONS BY THE SECRETARY OF THE PHILADELPHIA ELECTRIC COMPANY SECTION, IN APRIL, 1916

A STEADILY INCREASING MEMBERSHIP IS THE BEST EVIDENCE OF THE CONTINUED USEFULNESS OF THE COMPANY SECTIONS OF THE N. E. L. A.:



THE PHILADELPHIA ELECTRIC COMPANY

SECTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION ORGANIZED MARCH 15TH, 1909. PRESENT MEMBERSHIP UPWARDS OF 1100 · HOLDS MONTHLY MEETINGS FOR THE DISCUSSION OF SUBJECTS ALLIED TO THE POWER COMPANY INDUSTRY . PUBLISHES "CURRENT NEWS" 10 TIMES A YEAR MAINTAINS 3 DEPARTMENTAL BRANCHES — COMMERCIAL, ENGINEERING AND METER · ENCOURAGES ADVANCEMENT IN THE ELECTRICAL ART IN PHILADELPHIA

A typical "Calendar" of P. E. Co. Section activities, during the month:

APRIL MEETINGS

N. E. L. A.

3 — MAIN SECTION MEETING
Tuesday, April 3rd, 8 P. M.
NEW CENTURY DRAWING ROOM
124 SO. 12TH STREET

MR. WILLIAM C. L. EGLIN

2nd Vice-President and Chief Engineer
THE PHILADELPHIA ELECTRIC COMPANY

"THE POWER COMPANY AND THE DISTRIBUTION OF ELECTRICAL ENERGY"

What Mr. Eglin will say is the substance of his Talks given recently to students at Yale and Princeton Universities, illustrated with numerous lantern slides.

There are included: National Statistics on the Power Company Industry, historical matter of interest with reference to the great growth of Power Companies, and data on the engineering features of the generation, transmission, distribution and utilization of electrical energy in the best American practice, together with views of representative power developments from Coast to Coast.

As a Past-President of the National Electric Light Association, Mr. Eglin can discuss his subject authoritatively.

Nominations for Officers for the Years 1917-1918 will be made at this Meeting.

Surprise in Vaudeville — Band Concert 7.45 to 8.15

Secure your attendance cards from your Committee-man.

9 — AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
Monday, April 9th, 8 P. M. — Engineers' Club, 1317 SPRUCE ST.

UNDERGROUND CABLES
Their Manufacture and Use Under Modern Practice

By MR. HENRY W. FISHER,
Chief Electrical Engineer, Standard Underground Cable Co., Perth Amboy, N. J.

Recent developments in the manufacture of high voltage cables will be discussed in detail. The speaker will use lantern slides and will exhibit a number of samples of cable.

20 — ILLUMINATING ENG. SOCIETY
Friday, April 20th, 8 P. M. — Engineers' Club, 1317 SPRUCE ST.

SUBJECT AND SPEAKER
TO BE ANNOUNCED LATER

11 — METER DEPARTMENT BRANCH
Wednesday, April 11th, 8. P. M. — Engineers' Club, 1317 SPRUCE ST.

"History and Development of the Watthour Meter"

By MR. M. C. RYPINSKI,
Westinghouse Electric & Mfg. Co.

Here is your chance to learn in one night what it took the speaker years to learn.

Why not attend this meeting and find out how little you do know?

25 — COMMERCIAL DEPT. BRANCH
Wednesday, April 25th, 8 P. M. — Engineers' Club, 1317 SPRUCE ST.

SUBJECT AND SPEAKERS
TO BE ANNOUNCED LATER

16 — ENGINEERING DEPT. BRANCH
Monday, April 16th, 8 P. M. — Engineers' Club, 1317 SPRUCE ST.

"PROTECTIVE DEVICES"

By MR. H. CARL ALBRECHT,
Supt. of Station Construction Dept.

Practical talk covering lightning arresters, reactances, oil switches, circuit breakers, fuses, etc., and more fully the different types of relays and their actions

Maybe you don't have to worry what this is all about, but the speaker does. Let us show him his worrying is not in vain. He's doing it all for YOU.

27 — ELECTRICAL CONFERENCE
Friday, April 27th, 8 P. M. — Engineers' Club, 1317 SPRUCE ST.

QUESTION BOX NIGHT

Now is the time for you to ask any question relative to the Contractors, Inspections of Underwriters, City and the Philadelphia Electric Co.

Send your questions to the Secretary, Mr. Richard H. Silbert, 226 S. 11th St., and attend this meeting for your answer.

Here is your opportunity!,
What are you going to do with it?

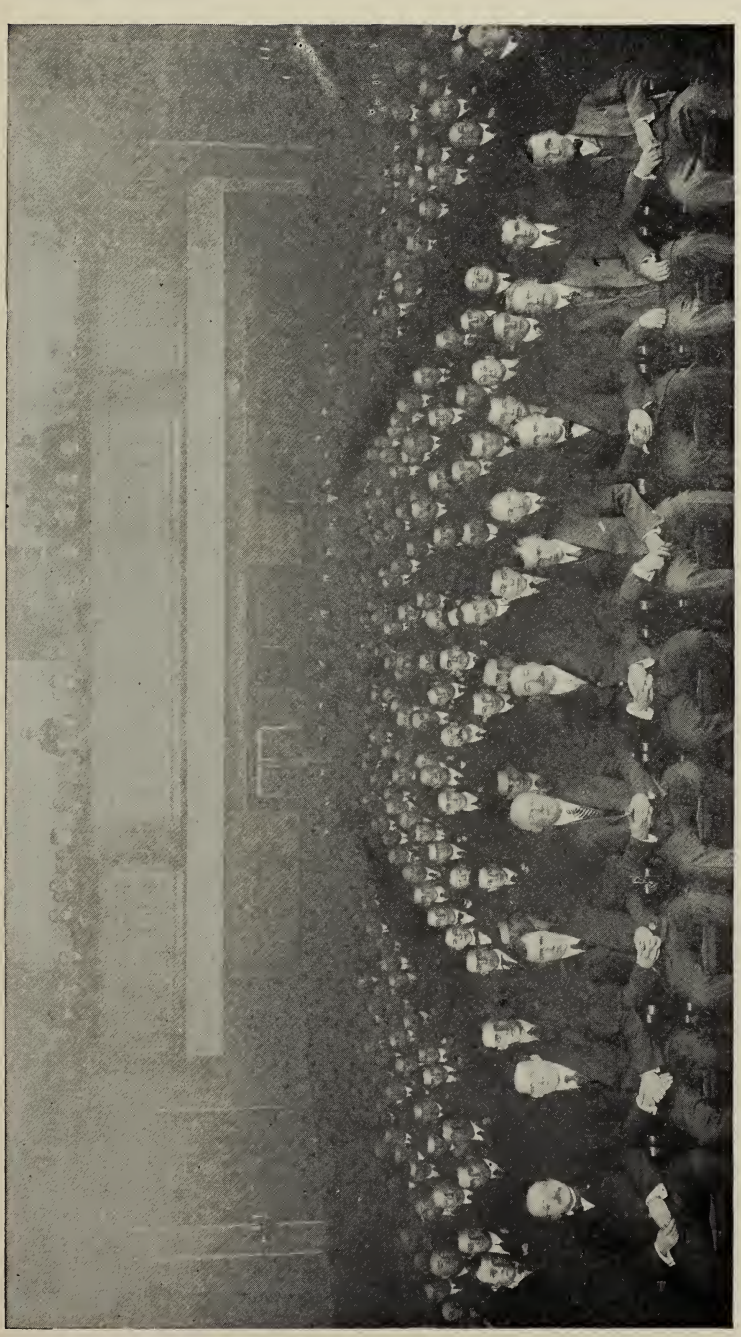
ONLY A CERTIFICATE FROM THE DOCTOR WILL EXCUSE YOU ON
MAY 12th—OPENING DAY AT KELLY'S LANE
If you believe in Company Welfare, you'll be there.

Every time you see it rain
Just stop and think of Kelly's Lane
Sunshine all the time

1917			APRIL				1917
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
1	2	3	4	5	6	7	
8	9	10	11	12	13	14	
15	16	17	18	19	20	21	
22	23	24	25	26	27	28	
29	30						

There's one place you don't need SAFETY FIRST at KELLY'S LANE
Try it MAY 12TH

MOST OF US DON'T HAVE TO WAIT UNTIL APRIL TO BE FOOLED



THE AUDIENCE AT THE APRIL MEETING OF P. E. CO. SECTION: MR. WM. C. L. EGLIN, SPOKE ON "THE POWER COMPANY AND THE DISTRIBUTION OF ELECTRICAL ENERGY"

association. The function of this association is to insure the employee effectually against sickness, accident and death for any cause; such insurance, although a matter of physical condition, always reacts favorably upon the state of mind. To guard against being imposed upon, the beneficial association insists upon a physical examination simultaneously with the employment of new men. Thus, after having been accepted by the company, the employee is automatically insured against any kind of accident—in or outside of the company's plant—sickness and death.

In case of sickness or accident the beneficial association renders all the necessary medical aid and advice. To cover the cost of this insurance—and medical service when required—a small per cent. is deducted from the men's pay.

The prevention of accidents and sickness is really more important than the curing of them; I have mentioned the latter first merely because of the insurance feature in connection with the beneficial association. The power company gives special attention to the prevention of accidents by the safe-guarding of machinery and the careful instruction of the men in the use of safety devices. Handling of live or supposedly dead electrical circuits, which is usually especially dangerous, is being done continuously and safely by Power Company employees who have been carefully instructed how to avoid accidents. All of the so-called dangerous employments which the Power Company calls upon its men to enter are carefully studied in order that means may be devised whereby the employee will be protected against all possible harm. Along the same line of this protection of machinery comes the training which is given the men in rendering *first-aid* to themselves or to injured comrades. The instruction in first-aid is given by competent instructors, and, of course, always includes detailed training in the "prone pressure" method of resuscitation. To encourage proficiency in the knowledge and application of first-aid principles, awards and prizes are given in frequent contests and examinations.

It is recognized that one of the most usual causes of accident and sickness is poor physical condition. The Power Company, realizing this fact, has encouraged outdoor physical exercise by the establishment of centers of open-air activities, where its employees can readily indulge in any reasonable game or sport under most congenial conditions.

The mental attitude of the employee is of as much importance as his physical condition. The question of worry is closely related to that of physical health, so closely in fact that good physical health, obtainable under the conditions outlined above, means to a large extent the elimination of worry.

The Power Companies have inaugurated what is known as a service annuity plan, which is intended to provide a certain scale of pay, depending on the employee's length of service and a certain pension, also depending

upon his length of service and rate of pay. The elimination of overtime work is another factor which contributes largely to the contentment of the employee.

Upon the educational opportunities for the employee depends in a large measure his advancement and future. One of the most potent educational forces in the power company world today is the National Electric Light Association. Established in 1885, it has grown up with the industry from infancy. It has branches and sections in every corner of the country, which co-operate with each other in educational and social matters for the general good. Membership in this great national organization is fortunately open to all employees of the member companies, many of whom have taken advantage of the splendid opportunities offered and have swelled the National membership to 15,000. In addition to the National body, many of the member companies maintain their own sections for the education and social interest of their employees. Some idea of the growth of a typical section can be seen from page 106. You will notice that the curve has the usual upward trend, which now you recognize as characteristic of all phases of the Power Company Industry.

IN CONCLUSION:

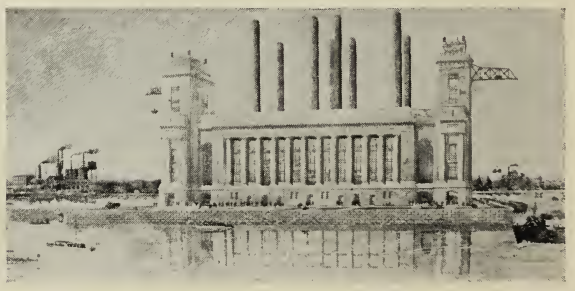
You will see that in these pages, I have attempted to give you something of the past history, the present standing, and in a limited way, a forecast of the future, of the American Power Companies; with the emphasis laid always on its meaning to College men.

Up until now it might easily be true of some of you, that the only conscious *direct relationship* that you have had with the Power Company industry, has been when you have "pressed the button" for the electric lights in your dormitory rooms!

My purpose in preparing this paper has been to seek to establish quite a different sort of relationship.

So that University men will be alive to the opportunities—alike to engineers and to Arts men—that lie open to them NOW, in this great, rapidly-growing industry.

FINIS



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THE NATIONAL ELECTRIC LIGHT ASSOCIATION

with headquarters in New York City, offers the interchange of facilities with accredited educational institutions, for mutual helpfulness.

Its Committee on Relations with Educational Institutions has for its objects: "To co-operate with educational institutions of various grades in determining on courses, curricula and facilities; to establish opportunities for undergraduates and graduates of technical schools to engage in central station work; to recommend to member companies, plans for educational opportunities for central station employees; to recommend to technical institutions subjects for research."

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"A far-reaching influence in the choice of his life work should be the Opportunities held out to-day by the Power Companies to the University-trained man"

—WM. C. L. EGLIN